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BROOKLYN BRIDGE BUSINESS FOR JANUARY was reported upon as follows at the last meeting of the trustees: The receipts from the carriageways, promenade and railway aggregated $99,369.69. The cash on hand Jan. 1 was $287,292.85. The expenditures were $63,018.97, leaving a balance in bank of $323,405.17. The total daily average of traffic receipts was $3,205.47. The total number of passengers was 3,595,939, being a daily average of 115,998. This was a decrease of 2,389 over the average of January, 1890.

THE COAL MINING INDUSTRIES of Maryland and Alabama are the subject of two census bulletins recently issued. The total production in Maryland for the census year 1889, the census year ending June 30, 1880, and the calendar year 1888, was as follows:

	Net tons.	Value at mines.	Per ton
1889	2,939,715	$4,517,474	85.6 cts.
1880	2,228,917	2,585,537	116.0 "
1888	3,479,470	.....	.....

There has been but a small general increase in the shipments since 1873. The shipments for 1873 amounted to $2,492,726 gross tons; for 1888, 2,934,907 tons; for 1889, 2,510,478 tons. Since 1883, the shipments by canal have steadily decreased from 490,913 gross tons to 53,293 tons in 1889.

In Alabama, the total output did not reach 100,000 tons until 1876. For the census year 1880 the production was 323,972 tons, valued at $476,911 at the mines. For the calendar year 1889 the production was 3,378,434 tons, valued at $3,707,426. The figures apply to the mining of coal and preparing it for shipment, exclusive of all expenditures for the manufacture and handling of coal.

UNDER THE WRIGHT LAW 28 irrigation districts have already been organized in California. In an article by Mr. L. M. HOLT in the *Tulare Register*, these districts have a combined area of 1,647,993 acres, or an average of about 59,000 acres each. The smallest district is the East Riverside, with but 3,000 acres, while the largest, the Madera, includes 305,000 acres. Of the 28 districts 5 are in the Sacramento, 8 in the San Joaquin Valley and 15 in Southern California. Twenty-five of the districts voted bonds to the aggregate amount of $11,092,000, and Mr. HOLT states that "13 of the districts have sold bonds in whole or in part to the extent of $3,975,000." In this connection it should be remembered that the districts have been organized but a short time, some of them for but a few weeks, and that the law went into effect only some two years ago. The districts which have voted bonds have a combined area of 1,382,000 acres, making the average amount of bonds per acre $8.02. In one of the districts the amount of bonds voted ranges as high as $83.33 per acre. This is the East Riverside district, with an area of but 3,000 acres, all of which, we believe, is under high cultivation. In the Madera district the bonds voted amount to but $2.78 per acre. As every one familiar with irrigation knows the rise in land values is very great after water is introduced, depending, of course, upon its location and degree of aridity and upon the nature of the crops grown under cultivation. A move is now being made to organize a permanent State association of irrigation districts for the good of all concerned, and it is probable that the effort will be successful.

SEWAGE FOR IRRIGATING the district below LOS ANGELES is proposed in a letter by L. M. HOLT to the *Evening Express* of that city. Mr. HOLT estimates that, with the sewage available from the present sewerage system, at least 3,000 acres could be irrigated, which would be increased to 8,000 or more when the system is further extended. He advocates the organization of an irrigation district under the Wright law, which shall purchase and utilize the sewage.

THE LONDON (ENGLAND) WATER SUPPLY BILL, which has been drafted under the direction of a committee representing various local authorities, provides for the creation of a trust, to be elected by county electors throughout the water area, which considerably exceeds the area of the county of London, with power to acquire, by agreement or arbitration, the undertakings of the eight companies now supplying the metropolis, and of two other companies supplying Rickmansworth and Leatherhead respectively. Under the bill power is reserved to the London County Council to adopt the act, in which case the Council will become the water authority for the entire area, and the creation of a special trust will be avoided.

THE STREET RAILWAYS OF THE UNITED KINGDOM have an aggregate of 948 miles, with 27,719 horses, 575 locomotives and 3,801 cars. Total capital authorized $93,895 per mile, with $71,210 per mile paid up.

THE FLOW INTO THE NEW AQUEDUCT, at Croton Dam, has been tested by Chief Engineer FTELEY. The gates at the dam were closed on Jan. 12 and opened again on Jan. 14, and gagings made while the flow was stopped. Exclusive of loss by percolation, which is about 150,000 galls. per day, the resultant gain to the supply from water along the line is nearly 4,000,000 galls. per day. The regular flow from Croton Dam is 60,000,000 in 24 hours at this time of the year.

A NEW CAR MOTOR, built by the Thomson-Houston Co., has been tested successfully on the West End Ry. in Boston. A few weeks ago notice was given of the Baxter slow speed motor, and the fact that the inventor had succeeded in reducing the number of gears ordinarily employed. The new Thomson-Houston motor was also designed to reduce the number of gears. Its armature is of the Gramme ring type, so arranged that any coil can be easily rewound without disturbing the others. On a truck with 30-in. wheels the bottom of the motor box is 4 ins. above the top of the rails. The steel armature pinion has 14 teeth 4½ ins. wide. The cast iron split gear bolted on the car axle has 67 teeth, so that the velocity ratio of wheels to armature is 1:4.8. At a speed of 10 miles an hour, the armature makes 538 revs. per minute. The gears are carried in close boxes, and the cars are remarkably free from noise while running.

THE EAST RIVER BRIDGE CO.'s bill was introduced in the New York Senate on Feb. 10 by Senator BIRKETT, of Brooklyn. This company modestly proposes to build two bridges across the East River with a capital of $24,000,000. The first bridge would cross from Broadway, in Brooklyn, to Rivington St., in New York. The second would commence near Fulton St. and land near the New York terminus of the first bridge. There is supposed to be an intimate relation between these bridges and a project for connecting the Union and Manhattan Elevated railway systems. The incorporators of the double bridge are: H. W. PUTNAM, HUGO ROTHSCHILD, E. SNEDECKER, SIMON UHLMANN, A. J. HARDENBURGH, A. LADENBURG, ISAAC LEWIS, R. T. POLLARD, G. W. WINGATE and FREDERICK UHLMANN.

THE NEW YORK & BROOKLYN TUNNEL CO. is asking incorporation at Albany. It proposes to dig a tunnel under the East River from Greenwich St., New York, to Smith St. and Atlantic Ave., Brooklyn. Capital, $15,000,000.

THE NEW YORK & NEW JERSEY TERMINAL CO. has filed articles of incorporation at Albany. This company proposes to build a railway, starting at the foot of East 14th St., in New York, run under the city in a tunnel on the line of this street, tunnel the Hudson River to Hoboken and pass by other tunnels under Hoboken and Jersey City to a point near the Hackensack River, and under this river to a junction with the Delaware, Lackawanna & Western and Pennsylvania railways, at Kearny, N. J. In New York City the road would have a branch running from Hudson to Chambers streets, thence south to Broad and Wall streets, and under Broad St. to the East River. Among the trustees named are THOS. STURGIS, WM. C. LANE, GEORGE H. TAYLOR, A. R. HERRIMAN and WM. C. COX.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of a passenger train on the Burlington, Cedar Rapids & Northern Ry., between Maynard and Randalia, Ia., Feb. 9. The accident is attributed to a broken rail. The engine remained on the track, but all the cars went down a 14-ft. bank into a sand pit. About 20 persons were injured, some seriously. The train was heated by steam, *but there was a stove in the mail car* which set fire to the wreck and several cars were burned. This one accident may cost the company more than the expense of fitting mail cars with steam heating appliances. Another serious derailment occurred Feb. 5, at Roe, Ark., on the St. Louis, Arkansas & Texas Ry. The engine ran over a horse and was derailed, together with the mail, express, baggage and smoking cars. One man was killed and 5 were injured. A singular accident occurred near Disko, Ind., on the New York, Lake Erie & Western R. R. Feb. 7. As an east-bound passenger train left Disko, a piece broke out of one wheel and threw a pair of wheels off the track, and the train ran 3 miles before the fact was discovered. A freight train following was ditched just after it left Disko, and an investigation showed that the derailed wheels on the passenger train had cut off the heads of nearly all the spikes, which caused the rails to spread when the freight train struck them. The wrecking train was sent for from Huntington, and the crew had to spike the 3 miles of track before they could reach the ditched freight train.

THE 100-FT. SPAN OF THE BRIDGE carrying the Belt Ry. over Pigeon Creek, at Evansville, Ind., gave way under a freight train Feb. 5. No lives were lost. A trestle about 15 ft. high on the Port Royal & Western Carolina Ry., near Woodlawn, S. C., was wrecked Feb. 4 by a derailed car of a freight train. Two persons were injured. The Alabama Mineral R. R. bridge across the Coosa River, near Shelby, Ala., was wrecked by the flood Feb. 7.

A SLIDE of 400 ft. of the north bank of the approach to the tunnel at Sarnia, Ont., occurred last week. No one was injured, but it is said that work on the approach will be delayed 2 months, and it is thought that some large brick buildings that are being erected near the cut will be affected.

THE BOILER OF A LOCOMOTIVE on the Cleveland & Canton R. R. exploded Feb. 3, while the engine was hauling a train, near Cleveland, O. The engine driver and fireman were killed.

New Passenger Station at Newark, N. J.; Pennsylvania Railroad.

The new passenger station at Newark, N. J., on the Pennsylvania R. R., now nearly completed, is of especial interest because of the provision made for the crossing of passengers from the main station on one side of the tracks to the waiting rooms on the other side by means of a tunnel beneath the tracks.

The importance of keeping passengers off the tracks at way stations on double track, trunk line railways is a matter which is only beginning to be appreciated. On roads of heavy, through traffic at stations in the vicinity of the larger cities, it often happens that a crowd may collect on the tracks to take or leave a local passenger train, and in case a through passenger train on another track runs past the station, the track may not be cleared in time.

FIG. 2. VIEW FROM MARKET ST. CROSSING.

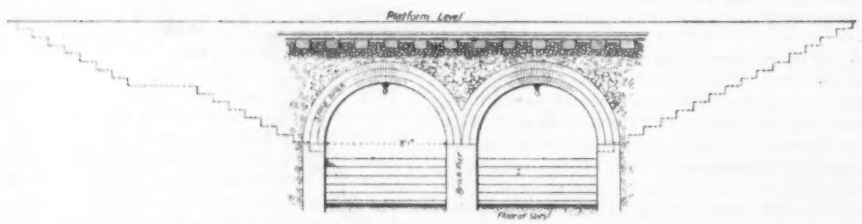


FIG. 3. CROSS-SECTION OF SUBWAY UNDER TRACKS.

The Massachusetts State Railroad Commission, in its report for 1889, called attention to the great liability to accidents of this sort occurring on the main lines of railway entering Boston, and urged the necessity of providing overhead bridges or subway tunnels at the important local stations within 12 miles or less of Boston to prevent crossing of the tracks by arriving or departing passengers. The report was accompanied by an excelleht monograph by A. GOERING, Professor of Railroad Engineering in the Berlin Polytechnicum, describing the arrangement of suburban stations on the Berlin, Potsdam & Magdeburg Railway. Public attention was directed to this matter in Germany by the accident on Sept. 2, 1883, at Steglitz, on that road. A through express train ran into a crowd of persons who were hurrying to enter a local passenger train standing at the station, and 37 persons were killed outright. It is to be noted that there was a fence between the tracks at the time this accident occurred, designed to keep passengers from crossing the tracks in front of approaching trains, but it was of no great height, and was provided with several gates. The crowd forced open the gates and jumped over the fence, notwithstanding the efforts of several employees.

In this country the Pennsylvania Railroad has been among the foremost in providing safe methods of handling traffic at important way stations in the vicinity of large cities; and many of its stations in the vicinity of Philadelphia and Pittsburg are admirably arranged to prevent crossing on the tracks.

If a railway station is located on a level considerably above the tracks, an overhead bridge is the obvious way of solving the problem. In case the railway tracks are carried through the station on a viaduct, a passage beneath the tracks is, of course, always available. At the very numerous stations which are on a level with the tracks, as is the case at Newark, the choice between an overhead bridge or a subway is not so easy. The advantages of the bridge are cheapness of first cost and no trouble with lighting, ventilation or drainage. On the other hand, it is apt to be unsightly as generally built, it exposes passengers to storms, and it requires considerably more ascent and descent than the subway. The necessary height of the floor of an overhead bridge above the station platform may be taken as 18 ft. The floor of the subway tunnel at Newark is only 12 ft. 5 ins. below the platform level, a difference of considerable importance. The great object to be attained in the design of either tunnel or bridge is to make the passage so easy and direct that passengers will not be tempted to take the longer but level way around and across the tracks. Foreign experience has shown that passengers generally prefer bridges to subways. But with subways properly built, lighted and ventilated this preference can probably be reversed.

The arrangement of the new Newark station is clearly shown in our illustrations. Fig. 1 is a plan of the station and tracks. All the traffic, freight and passenger, over the four tracks of the Pennsylvania's New York division is carried past this station over the two tracks shown. There are about four express trains each way daily which run through without stopping, besides from 15 to 20 each way which stop only for through passengers. Besides these, there are all the freight trains, which

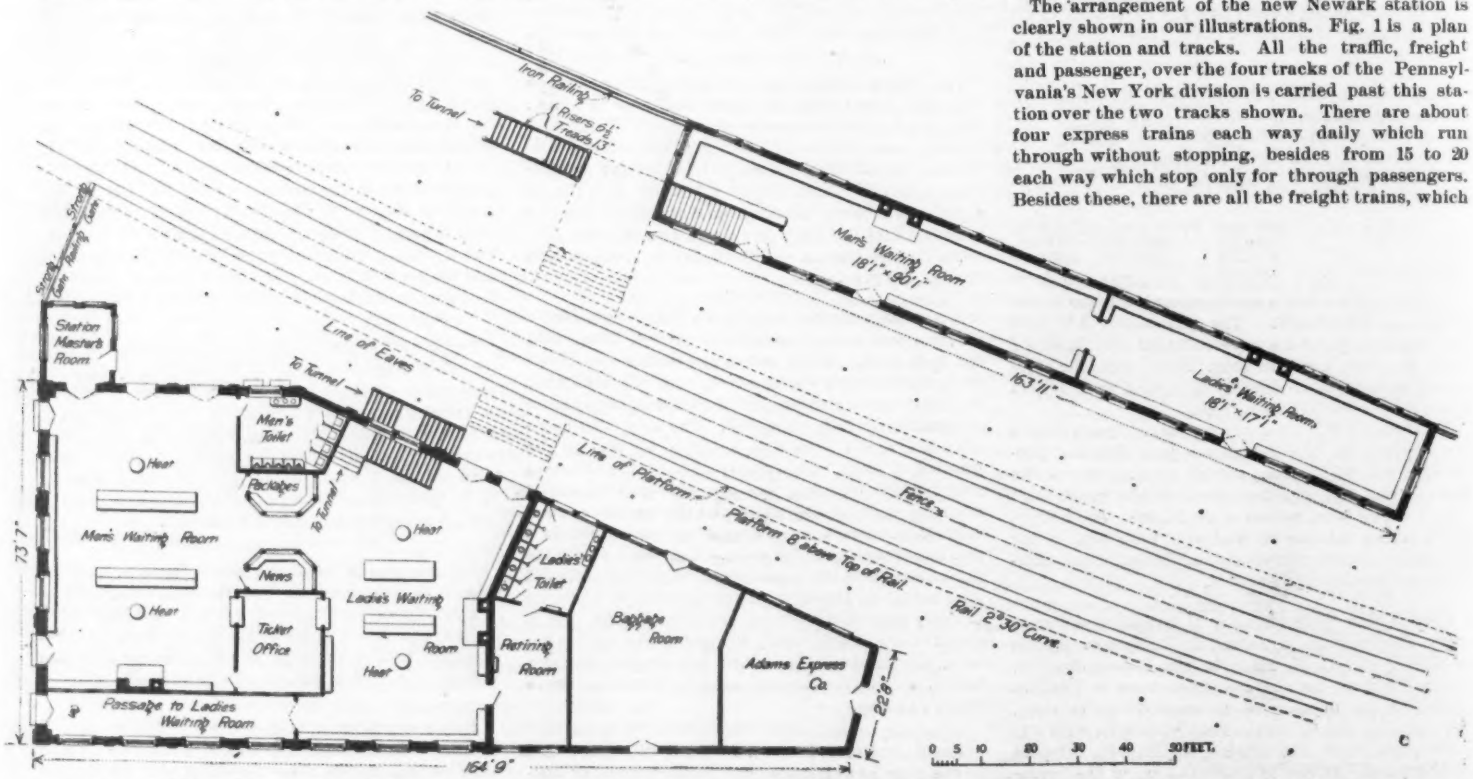


FIG. 1. GROUND PLAN OF NEW STATION OF THE PENNSYLVANIA RAILROAD AT MARKET ST., NEWARK, N. J. Wm. H. Brown, Chief Engineer.

of course do not stop, and numerous Lehigh Valley passenger trains, which stop only for passengers for points on that road. The necessity of keeping passengers off the tracks at the station is therefore evident, and, indeed, it is to be regretted that a separation of grades through the city is not to be carried out. It must eventually be made, however.

Just east of the station the railway is crossed at grade by Market St., one of the principal business streets of Newark, and it was necessary to prevent passengers going over this grade crossing instead of using the tunnel. This has been effected, as far as possible, by placing sliding gates at the end of the platforms next the crossing. Attendants at these can direct passengers wishing to cross the tracks to the tunnel, or can allow arriving passengers to go through the gates when it is safe to do so. The perspective view of the station, sketched from a photograph taken from the Market St. crossing, shows the sliding gate on the west bound platform. The waiting room and platforms on the other side of the tracks are still in process of construction.

To induce passengers to use the tunnel, access to it has been made as easy as possible. From the main station on the north side two stairways descend to the tunnel, one starting from the station platform and the other inside the station, at the passage between the main waiting room and the ladies' waiting room. A little deception has been practiced here, which may be pardoned since it is in a worthy cause, by dividing the stairway to the tunnel in two parts, separated by a right-angle turn as shown in the drawings. Only the first of these flights is seen by the person starting to descend, the last flight of six steps being beneath the platform, and the descent is thus made to appear more moderate than it really is. On the south side stairways descend to the tunnel entrance both from the men's waiting room and from the open platform. All the stairways are made very easy, with 6½-in. risers and 13-in. treads. The stairs are made of stone, which may possibly give some trouble from slipperiness in case of a damp, foggy day following severe cold weather. Good hand railings are provided, however.

Hardly less important than ease of descent are the matters of light and ventilation. The latter is provided for by leaving the passageway open at both ends. For the former, incandescent lights along the crown of the tunnel are provided; but except on very cloudy days they will hardly need to be lit during the daylight hours. The sides of the staircases and the whole interior of the tunnel and passageway are of light-colored enameled brick; and as each end is open to the light, the tunnel is very well lit without the lamps.

The matter of drainage is quite important, since a damp or sloppy floor would very quickly make the tunnel unpopular, and the bottom of the tunnel is below the level of the adjacent sewers. The floor of the tunnel is of narrow wooden slats, running lengthwise, with ⅛-in. spaces between. All water that may enter from any source, therefore, drains through to the cement floor beneath and runs to a cistern of 800 galls. capacity located just beyond the south end of the tunnel. A small steam boiler and pulsometer pump is provided to empty this whenever necessary, which will probably be very seldom.

Fig. 3 is a cross-section of the tunnel, showing also the stairs from the east-bound waiting room and platform. The reasons why two small tunnels are preferable to one large one are too obvious to need explanation. The arch is made of three rings of brick, making a total thickness of 1 ft. 6 ins. From the crown of the brickwork to the base of the rail is 1 ft. 6 ins., a little more than enough for the cross-ties and ballast. The arches have a total length of 27 ft. The remainder of the passage-way beneath the platform is roofed with I-beams, between which are turned arches faced with enameled brick.

A few words as to the station itself may be of interest. It is built of dark red brick, with brown stone trimmings, and the inside is finished in oak and light-colored woods. There is no second floor to the building, as might be supposed from the exterior, but the rooms are open to the roof, thus giving plenty of light and air. All the ticket and other offices are in the main station. The east-bound waiting-rooms on the other side of the tracks are used chiefly by commuters to New York City, and the accommodations provided are ample. The contractor for the whole work was G. W. ROYDHOUSE, of Philadelphia. The station was designed in the office of the Chief Engineer of the Pennsylvania Railroad, to whom we are indebted for the ground plan presented.

Although the approaches to the tunnel from the east-bound platform are not completed, it is already in use and seems to be appreciated by the traveling public. One point in the arrangements for securing safety which seems open to criticism is the low fence between the tracks. The top of the pickets is only 4 ft. above the base of the rail, and a large percentage of travelers would be likely to disregard all warnings and jump the fence if they feared missing a train. There may also be trouble from those who may leap the fence from pure recklessness. A fence a foot or two higher could have been built at practically the same cost and without injuring the appearance of the station. Still, low fences of this kind are largely used and we are unable to refer to any evidence that trouble of this kind has actually arisen from them.

The Elmore Process of Copper Depositing.

(FROM OUR LONDON CORRESPONDENT.)

This new and very remarkable process of making tubes and other articles of copper by electric deposition has been already described in ENGINEERING NEWS of Aug. 9 and Oct. 18, 1890; but its readers may not be aware of the great public interest which has been excited in England concerning the company through attacks upon its financial standing.

Taken as a whole, the financial papers of London are the black sheep among British journals, or, to make the metaphor more accurate, are the wolves in sheep's clothing, of which all lambs should beware. Many of these journals live almost wholly by blackmail. They assume a tone of candor, and pretend to advise the unwary provincial investor, but as a matter of fact, as has been shown in the course of recent judicial proceedings, they praise anything which they are paid to praise, and make a point of condemning those schemes which do not pay them blackmail.

The Elmore Co. has been presumably in the latter category, as a dead set has been made lately at it. The attack has been aided by a technical journal, which has on other occasions shown its incompetency in dealing with engineering subjects.

The Elmore Co. has somewhat foolishly played into the hands of its detractors by a policy of secrecy which was quite unnecessary. The directors have kept the works religiously closed to every one, even to the shareholders; and people have gone so far as to say that no works existed at all, and that the tubes which they pretended to make were smuggled over from France. The directors have at last seen the folly of this course, for the whole process is fully described in the patent specifications, and have just opened their works at Leeds to the inspection of a party of engineers, metallurgists, and members of the technical press, among whom was your correspondent.

Pure electrolytic copper is obtained for purposes of commerce by depositing the metal from an aqueous solution of copper sulphate by passing a current of electricity through the bath. Almost any form of article can be obtained in this way, for whatever the shape of the cathode on which the deposit is formed, the deposited copper will be of the same contour. Unfortunately, copper deposited in this way is of a spongy texture, and has a low tensile strength and a rough nodular surface.

To overcome this difficulty Mr. ELMORE introduced his burnishing process. In the bath in which the electrolysis is carried on, an iron mandrel revolves. On this as the cathode the copper is deposited from the liquor, or electrolyte, when the electric current is applied. The loss of copper from the electrolyte is made up from the anode, which consists of a mass of granulated copper placed in the tank. As the mandrel revolves and copper is deposited on its surface an agate burnisher passes along it, being pressed up to its work by a rubber spring.

The continuous rubbing of the copper, as it forms film by film, has a remarkable effect on the physical properties of the metal. Mr. ELMORE has produced copper which has quite upset all our previous notions of what copper should be. For instance, one specimen tested by Prof. W. C. UNWIN showed a tensile strength of 41.28 tons per sq. in. Every fitter knows that the physical condition of copper can be greatly altered by working under the hammer or rolls; but no one ever expected that copper could be brought up to the strength of a fairly high carbon steel by any process whatever. At first people were quite incredulous about the 41-ton test, although Prof. UNWIN's reputation is too good for any one to suppose that he was not acting in good faith; but the high result was thought to be due to some error in testing or some fault of the City Guilds' testing machine. Shortly after this, however, Prof. ALEX. B. W. KENNEDY tested three samples of Elmore copper, which showed tensile strength as follows: 26.64 tons (58,080 lbs.), 26.83 tons (60,090 lbs.), and 25.92 tons (58,080 lbs.). The extension in a length of 4 ins. was 17.5%, 14.3%, and 17.5%. The nature of the copper, it should be stated, was different in Prof. UNWIN's sample, the extension being only 7% in 10 ins. Another specimen tested by Prof. UNWIN showed a tensile strength of 39.29 tons, and elongation of 5.1% in 10 ins. The Elmore Co. guarantee to their customers 20 tons (44,800 lbs.) per sq. in. tensile strength, with elongation of 15% in 10 ins.

At Leeds we were shown through the company's factory, and saw the tubes in process of manufacture. The rough Chili bars are granulated by being melted and run into water. The company has now at work but one depositing building, although other buildings are nearly completed. This contains 60 tanks, about 12 ft. long, 18 to 24 ins. broad, and 30 to 36 ins. deep. They are coated inside with a special mixture of pitch and lime, which renders them liquor-proof and also acts as an insulator. The building is 200 × 40 ft. There are three high-speed engines, each of about 70 HP., driving two Edison-Hopkinson dynamos, and one Elwell-Parker dynamo, each of which gives a current of 750 amperes, and 50 volts tension. Another 80 HP. engine is to be added.

The following are some further particulars of the method of operating: An inch or so from the bottom of the tank a perforated copper tray is placed, and upon this is spread a layer of grain copper. The mandrels, which for tubes consist of simple cast-iron cylinders, receive first a thin film of copper by the ordinary cyanide process, and are then placed in the tank, their ends being supported in bearings. The mandrels are revolved by pitch chain gearing. The electric conductors are attached, the tank is filled up with a solution of copper sulphate and dilute acid, and the mandrels are set rotating. The burnishing is done by agate rubbers an inch or two square. These are held in jaws attached to arms, which can be dipped beneath the liquor, and are pressed against the mandrel by a spring or India rubber band. The agates are caused to traverse from end to end of the mandrel by a leading screw. When this mechanism has been put in motion, the current is switched on, and the process continues with no further attention until the tube, or other article, is completed.

There seems to be little doubt that the physical condition of the copper is changed by the burnishing. The copper is deposited so slowly that the burnisher works on successive films of only about $\frac{1}{1000}$ in. thickness, and it seems likely that this affects its molecular structure. This view is perhaps strengthened by the remarkable electrical conductivity of Elmore copper.

This has been found to be 2½% above the standard (the standard being the conductivity of chemically pure copper) and 4% above the conductivity of the purest copper in the market.

The cost of producing copper tubes by the Elmore process is estimated by Dr. HOPKINSON at ¼d. (one cent) per lb. Taking as a basis the usual English standard for the cost of rent and power (one penny per HP. hour). I have made estimates of the cost of the Elmore process, whose results show a cost even less than that of Dr. HOPKINSON.

The deposit takes place at the rate of about ⅛-in. per week. The process is continuous, work being carried on days, nights and Sundays. A tank 12 × 2 × 3 ft. would hold a mandrel 18 ins. diameter and nearly 12 ft. long, and the weight deposited at the end of a week would be 275 lbs. About $\frac{1}{10}$ HP. per tank is required for burnishing and turning the mandrel. At the Leeds works a 6 HP. engine furnishes power for the 60 tanks.

The output from these is about 5 tons (11,200 lbs.) per week, with only one engine and dynamo at work. When the extensions in progress are finished, the

output of the works will be 25 tons per week. The current density used is about 16 amperes per sq. ft. of cathode surface. The loss of pressure in each tank is about 0.9 volt.

An important feature of the process is the small amount of labor required. At the Leeds works a single attendant looks after the whole 60 tanks, and the only other labor employed is for running the boilers, engines and dynamos, and in placing and removing mandrels and stripping the tubes from them.

Pavements, Sewers and Drainage of Steep Streets.

The city of Duluth, Minn., extends along the shore of Lake Superior for about 6 miles and inland for approximately a mile. The ground slopes toward the lake at an average grade of 9¼%, and presents many difficult problems in municipal engineering. The separate system of sewerage was adopted in 1883, when the population was 5,000 and the expense of combined sewers could not be afforded, while the usual temporary expedient of cesspools was not advisable.

The city has since that time developed to such an extent that underground removal of storm water has become necessary, or at least desirable, on much of the territory. The grades of the avenues are so steep that the accumulation of water causes considerable destruction of roadways and sidewalks. The necessity of extensive improvements made it desirable to have expert advice and Messrs RUDOLPH HERING and ANDREW ROSEWATER were requested to prepare plans for an extension and improvement of the existing drainage system. From their report we make the following abstract:

Our examination of some of the sewers indicates very strongly the necessity of keeping stones and gravel from entering them. Although built only a few years, signs of slight wear are already apparent. It is further necessary to prevent stone and gravel from entering the sewers because it is difficult and expensive to remove such deposits after reaching the foot of the hill, where the velocity of the water is so much reduced that it will not carry the heavy matter out into the lake.

It is customary in other cities to build catch basins at the inlets to the sewers for the purpose both of preventing the silt from depositing and interfering with the discharge of sewage on flat grades, and also of preventing excessive wear on steep grades. We are strongly of the opinion that the most important improvement of the system constitutes the addition of catch basins at the street corners, and if found necessary, also at the alleys, in all districts where intercepting sewers will be required.

The great velocity of the water flowing down the gutters makes it necessary to build the basins in such a manner that this velocity will be checked when flowing through the basins and not be increased again until the water has escaped therefrom. The capacity of the basin is governed partly by the maximum amount of water, which, at a low velocity of say 2 ft. per second, will flow through it, and partly by the greatest amount of solid matter which is expected to be deposited during a single storm. To prevent the possible failure of a basin by becoming choked up with debris and therefore causing the water to flow past it down the avenue and overcharging the next basin, we think it desirable, as a matter of safety, to proportion the basins of double capacity.

To check the velocity, we advise the placing of a fender across the inlet in the path of the stream, as shown in Fig. 1, and in order to prevent the water from permanently remaining in the basin, a small drain should be laid from the bottom to the outlet pipe likewise, as shown upon the drawing.

As unimproved streets, and avenues paved with gravel, are likely to cause a larger amount of gravel to enter the catch basins than streets having improved pavements, we advise increased size in such cases. At the upper end of the graded avenues, to which drains have been built, it may be found expedient to build a specially large catch basin of timber for a temporary purpose, which later can be replaced by a smaller one of permanent construction.

It is evident that to secure the effective working of catch basins they must be cleaned out after every storm. To prevent the entrance of a considerable amount of the arger refuse, we recommend that the gutters of the gravelled streets be covered with gratings.

Inasmuch as the conditions are somewhat unusual in this city, it will be necessary to determine the best dimensions and detailed construction of the basins by actual experience. The accompanying cut indicates as nearly as we can judge the best proportions and arrangements for the conditions presented.

Washouts on steep grades can be prevented either by permanent pavement or by reducing the quantity of storm water running down the avenues. We have indicated that the latter can be accomplished by catch basins and by interception and conveyance to the natural water courses.

The sectional forms of streets, avenues and alleys at intersecting points are more or less dependent upon the grades, and upon the relative proximity to the business or residence sections of the city. At the intersection of avenues with streets in the business portion of the city, the limits of gradients for crossings must, for obvious reasons, be less than upon streets in the residence portion. In both cases, however, certain prescribed limits of form are essential to the requirements of traffic and drainage. These limits are fully shown on the drawing accompanying this report. Briefly summarized they are as follows:

Upon all streets and avenues in the city, except in the business section, the curb grades should be unbroken between intersecting curbs. In the business section of the city the lines of curb grades, when exceeding 8%, should be broken at the street or property line. All street crossings from the curb on one side to the curb on the other, irrespective of location, should be designed on the basis of a 3% slope, except when the slope of the intersecting streets or avenues is less, in which case the grades shall be continued unbroken over the crossings. In determining the height of the block corners the elevation of the curbs at the two opposite points should be added to the rise of the two walks from their respective curbs to the corner, on the basis of 2½% inclinations, which sum divided by 2 will give the desired elevation. In other words the block corner shall have an average of the elevations determined from the two opposite curbs after allowing the usual rise in the walks of ¼ in. per ft. across their width. Upon steep grades, to facilitate the entry of vehicles to the alleys, made difficult by the side slope of the avenues, it will be best to reduce the alley width across the sidewalks, from 20 ft., their present width, to 10 ft. After allowing for 1 ft. slope across the remaining 10 ft. of the alley, increase the grade of a portion of the curb and walk on each side of the alley opening, and if necessary provide steps. These features are more clearly outlined in Fig. 2. Without these provisions the entry to and from the intersecting alleys from steep avenues would be somewhat hazardous.

Upon steep avenues already graded and paved, the accumulated flow of water at the gutter lines is so great that stones ranging in diameter from 8 ins. down to the ordinary gravel, move toward the inlet with such velocity that only the largest of these stones are successfully kept out of the sewers by the intercepting inlet bars. To prevent this, there are two remedies feasible. One of them is to cover the gutters along their entire lines with wooden gratings in the manner shown in Fig. 3. The cost of such covering will range from 15 to 25 cts. per lin. ft. The other remedy is to reduce the depth of volume and velocity of flow on the surface, by eliminating the crown and gutters of the avenues and making them practically flat. Ordinarily streets are crowned to secure ready drainage, but your avenues having steep slopes, require no such provision. The first of these remedies is suggested as suitable for the avenues already paved or curbed and guttered, and the other for

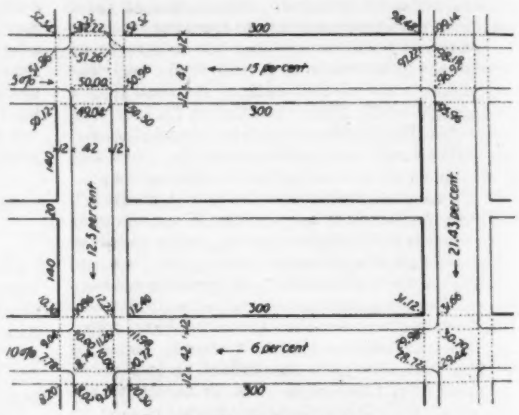


Fig. 2. Street Intersections.

avenues not yet improved, and in connection with catch basins described above.

Where streets or avenues have inclinations exceeding 16%, they are practically useless as thoroughfares. The center of the blocks and alleys upon the avenues can be more practically approached by the construction of high walls across the line of these avenues, to a depth and

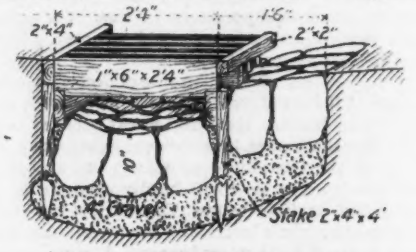


Fig. 3. Gutters for Steep Streets.

height to admit of the reduction of these gradients, from the center of the block each way, so as to bring them within easy access of teams to the rear of the lower lots from below and of the upper lots above. These walls, to accommodate pedestrians, should be provided with steps along their outer face and with a proper fence, as a safeguard against accident. Such a structure can be cheaply built, and is the only practical solution of the gradients on avenues ranging from 16 to 32%. As a further means of improving the avenues upon steep inclines, we advise the reduction of the roadway to a width not exceeding 30 ft., and a corresponding increase in the width of the sidewalks. This will reduce the cost of paving 28%. In our opinion the paving of a greater width upon steep slopes is a waste of money.

In the selection of suitable paving material for streets, two factors present themselves for consideration, namely, the surface or wearing material and its foundation. The life of pavements and their satisfactory maintenance depends as largely upon a durable and unyielding base as the walls of a building depends upon the solidity of its foundation, to preserve it from cracks and uneven settlement. The selection of economical paving material should be based upon a due consideration of the bed and gradients of the streets or avenues to be paved, and of the available facilities for efficient drainage. With clay or rock beds and light gradients, either sand, gravel, broken stone or concrete, can be used with reasonable assurance of good results. With steep gradients or wet, marshy soil the stability of the foundation enters largely into the question. Experience demonstrates that under all the varied conditions, a foundation of concrete, composed of broken stones or gravel, and cement mortar in suitable proportions, is the best; a bed of compact layers of broken stone (macadam) is the second best; gravel comes next, and sand last, of the four materials mentioned.

In view of the importance of preserving the foundation in proper form, and to counteract the tendency to washout or settle unevenly, on the steep grades of the Duluth avenue and streets, we suggest the use of either concrete or broken stone in layers, thoroughly compacted. On streets built upon low or filled in ground, broken stone or gravel will do well. Sand should only be used as a

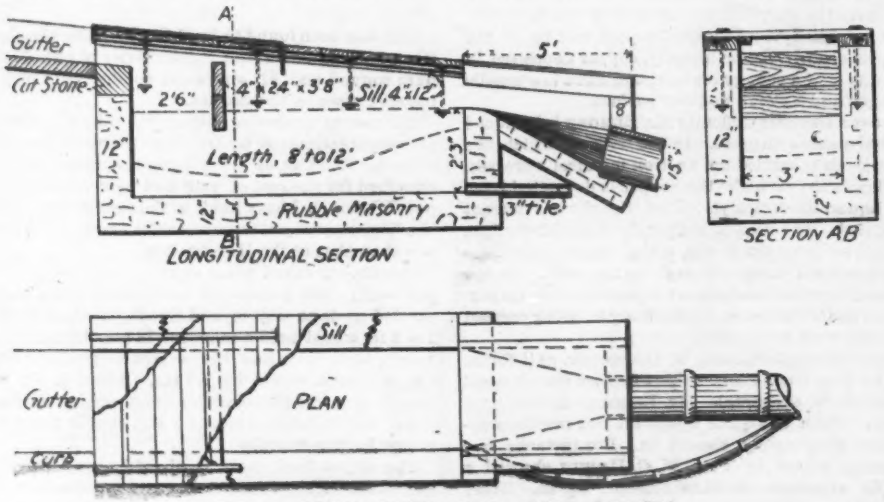


FIG. 1. CATCH BASINS FOR STEEP STREETS.

foundation upon the more level roads having a compact natural bed. Where there is danger of moisture penetrating the road bed, a line of blind drains should be laid below the curbs, discharging into the corner inlets.

To prevent the foundations from sliding on steep gradients, they should be anchored at suitable intervals by concrete ribs or bars, of from 6 to 12 ins. in depth below the concrete base, placed across the avenues.

The character of the wearing surface or paving material to be selected and the method of its preparation depends largely upon the price of the material available for such purposes, its adaptability to the gradient of the surface to be paved, its relative durability, its liability to derangement after being laid, the cost of maintenance, and upon the liability to interfere with the drainage.

To meet the requirements of travel, a paved surface must be favorable to the easy movement of horses and vehicles. It must be able to resist the disintegrating action of the elements for a reasonable number of years, for sanitary reasons it must be capable of ready cleansing, and lastly, easily repaired at reasonable cost. To be

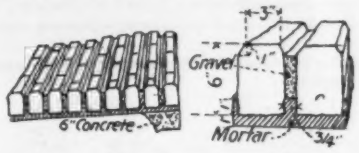


Fig. 4. Chamfered Granite Blocks.

Fig. 5. Kidney Stone Pavement.

Fig. 6. Brick Pavements.

Fig. 7.

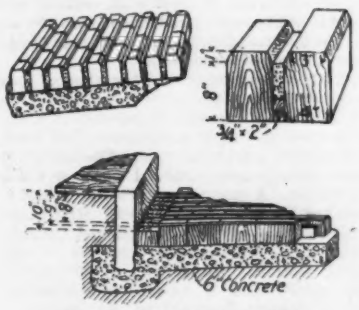


Fig. 8. Pine Block Paving.

favorable to the easy movement of horses and vehicles, the pavement must afford a secure foothold to the horse, must admit of such rapid transit as the gradients of the roadway will allow, with the minimum jarring of the wheels, and in connection with the most effective foothold, must develop the least resistance to traction. In other words, for light vehicle traffic, a pavement must admit of the best attainable speed; it must be as noiseless as possible, and produce the minimum amount of jarring to the vehicle. The extremes in the gradients of roadways, which prevail in the city of Duluth, reaching as they do to 32%, calls for a diversion from the usual form and manner of application. Of the pavements which we deem suitable to the conditions presented in Duluth, we suggest the following within the specific limits named:

STONE.

On grades of 10% or less:			
Rectangular stone blocks of the usual size and pattern, with sand joints, to be laid on a foundation of concrete or broken stone.			
Probable cost per sq. yd	$2.75	to	$3.25
On grades exceeding 10%:			
(1) Rectangular stone blocks, ranging from 3½ to 4 ins. in width, and chamfered on the upper edges, as shown in Fig. 4. The chamfering is needed to afford a safe foothold essential for horses to overcome very steep grades.			
Probable cost per yd., if laid on a broken stone foundation	2.75	"	3.25
And when laid on concrete	3.00	"	3.50
(2) Kidney or cobble stone, Fig. 5, selected of nearly equal sizes, not exceeding 3 ins. in thickness, laid on a concrete foundation and set in cement motar.			
Probable cost per yd	2.00	"	2.50

BRICK.

On grades up to 6%:			
Best paving brick laid on concrete.			
Probable cost per yd	2.25	"	2.75
On grades exceeding 6%:			
Best paving brick of the special form shown in Fig. 6, laid on a concrete foundation.			
Probable cost per yd	2.50	"	2.00

SHEET ASPHALTUM.

On grades less than 4%:			
Laid on concrete.			
Probable cost per yd., maintained for 5 years	2.25	"	3.00
Probable cost per yd., maintained for 10 years	3.00	"	3.50

WOOD.

On grades of less than 6%:			
Ordinary round cedar blocks laid on concrete.			
Probable cost per yd	1.80	"	2.00
Ordinary round cedar blocks laid on broken stone and boards.			
Probable cost per yd	1.50	"	1.60
Rectangular pine blocks of usual form and size, laid on concrete foundation.			
Probable cost per yd	2.25	"	2.40
On grades above 6%:			
Round cedar blocks, from 4 to 5 ins. in diameter, and chamfered to a diameter of 3 ins. at the top, as shown in Fig. 7, laid on concrete.			
Probable cost per yd	2.00	"	2.25
Rectangular pine blocks, with chamfered edges, either as shown in Fig. 8 or plain with a width of 3 or 3½ ins., and set with 1 to 1¼ in. joints, both laid on concrete.			
Probable cost per yd	2.40	"	2.60

In order to realize the advantages of the chamfered blocks and wide joints for the purpose of affording a foothold on steep grades, it is important that the pavements be frequently swept and the grooves between the blocks be kept open.

While macadam and telford pavements possess unexcelled merit as roadways, the expense of maintenance places them, together with gravel surfaced roads, in the list of temporary pavements. In view of the constant tendency of their component parts to wash into the gutters and inlets their use is not advisable for steep grades. However, if the upper layer of either of these pavements is treated with coal tar, binding the parts together, it is possible they will satisfactorily meet all the demands of a temporary pavement for gradients up to 16%.

For grades exceeding 10% we suggest the following pavements:

(*a*) Rectangular stone blocks with chamfered edges; (*b*) kidney or cobble stones; (*c*) best hard and tough paving brick, of special form; (*d*) cedar blocks with chamfered edges; (*e*) pine blocks with chamfered edges or wide joints.

Of the above pavements we regard the chamfered stone blocks the best, but most expensive, and the pine blocks the least desirable, because the least durable.

Cement, Hydraulic Lime, Roman Cement, Portland Cement.

(*Concluded from p. 127.*)

BURNING OF CEMENTS.

The burning of cements is usually carried on in vertical kilns or ring kilns. The vertical kilns are distinguished from the ordinary lime-kilns in being very solidly constructed of fire-proof materials, and also in having a smoke stack situated on top of the kiln. The kiln is charged with alternate layers of coke and cement material. In this the thickness of the layers of coke has to be varied according to the temperature required, which as has been said before varies considerably with different materials. The fire is lighted at the bottom and the kiln is then left to itself until the burning is completed. Usually the time of burning for a five ton kiln is twenty-four hours, for a 100 to 150 ton kiln 30 to 40 hours. The burned material is then taken out either before or after cooling and the fused portions are broken off. BERTINA, TOMEI and others have invented continuous vertical kilns. TOMEI'S kiln uses 30 per cent. less fuel than the ordinary kiln just described.

During the past few years, vertical kilns have been displaced to a great extent by HOFFMAN'S ring kiln. These kilns consist of a number of communicating chambers which together form an annular canal. Each individual compartment can be placed in communication with the outer air, with the neighboring compartments, or with the central stack by means of doors and dampers provided for that purpose.

Suppose, for example, that one of these kilns has 12 chambers, which, for convenience, we will call 1, 2, 3, 4, etc. Then the air enters chamber 1, passes through 2, 3, 4, etc., until it reaches 10, when it passes into the stack. (Two chambers are always being filled or emptied.) The fuel is always in the chambers opposite the one where the air enters, and it is in these that the principal burning takes place, since only the hot air from these passes through 8, 9 and 10, giving their contents a preliminary heating. When the contents of 5 are sufficiently burned, the supply of air and fuel and the draft into the stack are moved one chamber ahead. Then all the chambers from 2 to 11 come into use, 12 and 1 are being filled or emptied, the burning takes place in 6, 7 and 8, and thus the process is continued indefinitely. The cold air which must pass through several chambers in order to reach the seat of combustion cools them so that they can be filled or emptied without delay, and the air itself is heated to some extent. The smallest ring kilns have a daily capacity of 2,500 and the largest of 50,000 or more bricks per day. Besides the advantage of continuity in operation, the ring kiln uses 40 to 70% less fuel than a vertical kiln of the same capacity.

The proper temperature for burning cements varies somewhat with the raw materials used, and must be experimentally determined for every mixture used. In general it is about a white heat (2,000°). It is of great importance that all the material should be uniformly heated. The color changes of the clinker are used in judging of the progress of the burning process. At a dark red heat the calcium carbonate is converted into the oxide, and the clay is decomposed; the mass is then yellowish brown in color; at this point the hydraulic properties of the substance are very limited. At a white heat the color becomes darker, and the calcium oxide begins to affect the aluminum silicate; at a clear white heat the color becomes greenish gray, and the hydraulicity is the greatest; any further rize in temperature is injurious. The burned clinker is a hard porous mass with vitrified particles scattered through it, and is usually of the color given above.

After being taken from the kiln the clinker is immediately broken up and then pulverized. According to the investigations of several authorities on this subject, the hardness of a cement depends directly on the fineness to which it has been ground.

For the first breaking of the coarse clinker, several forms of stone crushers are used, while the final grinding is usually carried on in mills resembling the ordinary stone burrs used in flouring mills; roller mills and mills with vertical stones are also used.

In order to separate the coarse particles the cement powder is then passed through a sifting apparatus consisting of cylindrical sieves pierced with 1 m. m. openings covered with wire gauge. The cement is then packed for transportation in sack or barrels, and must be well protected from the air on account of its affinity for carbonic acid and water.

In regard to the substances which are added to the cement both before and after burning or during grinding, several different methods are employed. Fusible substances such as diabas, diorite, iron ore and fluor-spar are often added before burning. According to ERDMENGER these (especially the latter) aid the burning considerably without giving rise to any glassy vitrification.

Recently blast furnace slag has attracted considerable attention as a substance to be added after burning. According to DYCKERHOFF and BÖHME (General Assembly German cement manufacturers, 1884) blast furnace slag and other substances such as limestone, lime, fine sand, etc., lessen the firmness of most cement mortars, but that after a long time the hardness of some mortars is increased by additions of puzzuolannas, trass and slag, as has been shown by MICHAELIS. The association of German cement manufacturers permits the addition of such substances to an amount not exceeding 20%. As to the effect of additions of lime and sand on cement mortars, we have the results of DYCKERHOFF'S investigations, according to which lime has a very favorable effect on weak hydraulic limes, but on the contrary injures fat cements.

The sulphates, sulphides, hyposulphites and iron pyrites, if present in the raw materials, are very injurious.

The following materials are used for coloring cements: For black, brown stone; for red, caput mortuum; for green, ultramarine green; for blue, ultramarine blue; for yellow and brown, ochre.

Chemically considered, Portland cement consists of certain chemical products resulting from the combination of the calcium with the silica and alumina; these combinations taking place under the influence of a high temperature. LE CHATELIER has recognized the following substances by examining thin sections of cement by means of a polarization microscope taken in connection with a synthesis of the materials found: Tri calcium aluminate Al_2O_3 3CaO (calcium peridote) and calcium silicate Ca_2SiO_4. According to him the essential substance is a ferro aluminate $2(AlFe)_2O_3$ 3CaO, which is readily fusible. LANDRIN on the other hand believes that the two soluble aluminates Al_2O_3 2CaO and Al_2O_3CaO are contained in the cement.

The following table shows the composition of the principal kinds of Portland cements:

1, 2 and 3, Folkestone cements; 4, White Bros.' cement; 5, Stellen cement; 6, Stern cement; 7, Wildauer cement; 8, Bonn cement; 9, Gebriel Heyn's cement.

	1	2	3	4	5	6	7	8	9
CaO	61.350	62.476	61.459	60.20	62.81	61.61	61.91	57.18	62.02
MgO	0.669	.841	.449	.82	1.14	.....	1.15	1.33	1.13
Al_2O_3	8.809	8.763	6.563	6.92	5.27	6 17	7.66	9.20	6.52
Fe_2O_3	4.926	4.412	5.386	3.41	2.00	2.13	2.54	5.12	2.92
Na_2O	.978	1.100	.437	.73	1.27	.....	.77	.58	.57
K_2O	.....	.....	.429	.87	.....	.....	.46	.70	1.70
SiO_2	20.99	18.917	21.307	24.07	23.22	23.00	24.19	23.36	22 58
H_2SO_4	.886	.929	1.422	1.07	.....	.....	.....	.64	1.15
$CaSO_4$	.....	.....	.....	.....	1.30	.....	.....	.....	.....
Insoluble	1.26	2.506	2.894	1.47	2.54	....	1.32	.....	.....
CO_2	.....	.....	.....	.....	.....	.....	.....	1.90	.....
H_2O	.....	.....	.....	.....	.....	.....	.....	.....	7.15

The form and fineness of the cement particles are of great importance in the setting of the cement. Under the microscope Portland cements appear as a mass of thin scaly particles which lie close together. Hydraulic limes on the contrary consist of a mass of rounded particles. In the first the surfaces in contact are much greater than in the last, and accordingly we find that the tensile strength of Portland cements is much the greater. The coarser particles of cement powder act simply as so much sand. MICHAELIS says that with ordinarily ground Portland cement from 20 to 40% will not pass through a sieve having 900 meshes per sq. c. m., and that this is utterly worthless as far as any hydraulic properties are concerned. He also states that a well ground cement should have more than 25% of its weight in such a sieve.

The color of the cement should be grayish, especially not yellow or blue. Blue indicates an excess of calcium, while dark green shows a large percentage of iron, if the cement has been well burnt.

The density of cements varies from 2.7 to 3.2 and in general is higher with well burned cements. According to the standards adopted by the Association of German Cement manufacturers in 1884, good cements should have a specific gravity of not less than 3.1 to 3.125.

The permeability of a cement by water is of considerable importance when it is to be used for tubes, reservoirs, etc. MICHAELIS has constructed an apparatus for determining the amount of water which passes through a plate of cement of a certain size in a given time. In this the cement plate is placed over an exhaustible cylinder and the water is forced through it by atmospheric pressure. In another apparatus the speed with which the water rises by capillarity in a cement cylinder is measured; the cylinder being graduated and one end dipped in water.

THE SETTING OF CEMENTS.

By the setting of a cement we mean the change of the cement from the pulverulent to the solid form, either when mixed with water alone or with water and other substances. The quantity of water used should be regulated according to the kind of cement, since every cement has a certain given capacity for water; of course, however, in practice a quantity that is somewhat greater than this must generally be used.

The amount of water absorbed from the air by Portland cements (1) and hydraulic limes (2, 3, 4) varies considerably with the time, as will be seen by the following table by FEICHTINGER:

	1 P. c.	2 P. c.	3 P. c.	4 P. c.
Fresh ground	.99	1.28	.61	6.79
After 4 hrs.	1.41	1.67	.71	7.80
" 20 "	2.29	2.08	1.14	8.26
" 3 dys.	5.62	3.42	1.82	8.07
" 7 "	6.58	3.85	2.15	11.20
" 14 "	7.96	4.46	2.63	11.80
" 28 "	10.52	8.30	6.20	14.48
" 80 "	11.56	9.50	7.40	14.65

In practice about 50% of water is generally used, which is a great excess, so that there is usually about 30% of water to be driven off by evaportion.

The more vitreous the character of the cement, and the harder and sharper it grains, the longer is its time of setting. Cements which require more than one-half hour to set are called slow setting, all others quick setting. It is also a well known fact a cement does not attain its maximum hardness until some time has elapsed, often not until many months have passed. For good Portland cement fifteen days usually suffices for complete setting, *i. e.*, not complete hardening. The rapidity of the setting depends to a great extent on the temperature, and also, but in less degree, on the purity of the water.

It has been known for some time that sea water hinders the setting of most quick setting cements, and that some cements which are very hard in fresh water only harden slightly in salt water or even remain soft. VICAT attributes this principally to the action of the magnesium sulphate of the sea water on the lime, converting it into calcium sulphate, yet FEICHTINGER's experiments would make it appear that, beside the magnesium salts, the chlorides of calcium, sodium and potassium take part in this process. RIVOT and CHATONEY attribute this action to the carbonic and sulphuric acids present in the sea water, and also to the magnesium salts contained in it. To avoid this action KUHLMANN recommends adding sodium silicate (water glass) to the mortar. MICHAELIS advises a double or triple coat of this material.

The rise in temperature is much more apparent in the setting of quick setting cements than in others, because the external cooling is relatively much less.

HERZOG obtained the following results concerning the rise in temperature of a Portland cement, which he formed while wet into a prism 10 centimeters long, and at another time into a prism 20 centimeters long. In each case the original temperature was 13.5° C.

10 centimeters long.		20 centimeters long.	
Immediately after moulding	16°	Immediately after moulding	19°
After 30 minutes	17°	After 1 hour and 30 minutes	20.5°
" 70 "	17.5°	After 2 hours and 20 minutes	22°
" 4 hours	18°	After 4 hours and 30 minutes	24°
" 5 "	18.5°	After 5 hours and 30 minutes	38°
" 6 "	23.5°	After 7 hours	43°
After 7 hours and 30 minutes	27°	" 8 "	45°
After 8 hours max.	29.5°	" 8 hrs 30 min. max.	45.5°

Thus we see that the temperature increased 16° in one case, 32° in the other; accordingly the rise in temperature was proportional to the side of the cement prism. Thus it will be seen that all theories about the rise in temperature of setting cements, have no value unless they take the volume of the cement into account.

The volume of the cement should remain constant through the whole setting process. It is especially important that the cement should not increase in volume or swell, as it is called. This is due to the presence of free calcium oxide, which, on taking up water, expands, forming the hydrate. According to MICHAELIS "a properly composed cement should exert so great a resistance to the expanding calcium hydrate by the hydratization of its constituents and the intimate mechanical intermingling of the resulting hydrates that no swelling can take place. He says in support of this that good cement mortars do not swell when lime has been added to them.

The swelling of a cement may be shown by allowing the plaster to harden in a glass vessel, which will be broken by any change in volume, but sometimes the rise in temperature will effect this result. More certain results may be obtained by spreading the cement paste on glass plates and allowing it to harden; any change in volume will be shown by the cracking of the material.

According to ERDMENGER the cements made from dolomitic limestones show a great deal of swelling.

One of the most important qualities of cement is its compressive strength; since the direct determination of this is a matter of considerable difficulty, the tensile strength is the standard most generally adopted in determining the strength of a cement.

"Good cements should have a tensile strength after setting under water four weeks, of not less than 10 kilograms per sq. c. m.; most good cements will give considerably better results, from 15 to 25 kilograms and more.

In the case of Portland cements, according to most authorities, the relation between tensile and compressive strength is reasonably uniform, yet this is not the case, when weak hydraulic limes are to be considered, and no reliable conclusions regarding their compressive strength can be obtained from tensile tests. In this case the compressive strength must be obtained by direct determination. Such tests are usually made with prisms of cement, and a good cement should have a compressive strength about ten times as great as its tensile strength. DYCKERHOFF says that the form of these test specimens affects the results, and if they are made in the form of disks the results obtained are much higher.

The hardened cement should be but slightly dissolved by water. According to FEICHTINGER, 15 grains each of Portland cement and Bavarian hydraulic lime dissolved as follows in sixty liters of water.

	Portland cement.	Hydraulic lime.
Calcium	1.408	.868
Alumina	0.032	.020
Silica	0.102	.137

Cement masonry under water is protected from most destructive agencies by the water itself. For the carbonic acid of the water combines with the lime of the cement, forming a protecting layer of calcium carbonate, so that cements that have been long under water contain 15 to 18 per cent. of calcium carbonate.

The hardening process which takes place when a cement is mixed with water has been explained in many ways, and as yet no theory has been advanced that fulfills all the conditions of the problem. Most authorities, however, ascribe the action to the formation of calcium silicates and aluminates, or else double silicates of calcium and aluminum, which contain water of crystallization. Opinions differ, however, as to the manner in which these substances are formed, some claiming that they are formed in the process of burning, and exist in the anhydrous condition in the dry cement, and that they immediately crystallize out on the application of water. Others hold that at any rate the formation of these substances is only partially completed by the burning process, and that they are formed while the cement is setting by the action of calcium hydrate on the burned silicates. FEICHTINGER says that the incipient setting of a cement takes place in the manner first described, while the slower hardening process is due to the action of the calcium hydrate on the silicates.

SCHOTT found that mixtures of calcium, silica, alumina and iron, in the following proportions produced very good cements when properly burned and ground:

	1	2	3	4
Silica	24.8	23.8	23.3	24.3
Alumina	11 4	....	6.5	6.9
Ferric oxide		11.4	4.7	4.8
Calcium carbonate	64.8	64.8	65.4	64.1

From this he assumes that the hardening of a cement is not due to any certain chemical process, and KNAPP, who also inclines to this opinion claims that it is due to the mutual action of chemical and mechanical processes.

OTHER KINDS OF CEMENT.

Attempts have been made recently to make cement from blast furnace slag, and a very hard cement has been produced by burning 4 parts of slag with 7 parts of limestone. In WATSON's patent process slag is burned with limestone and clay. ROTH proposes to burn slag with lime and banxite until the mixture is vitrified.

In SIEBEL's patent process equal parts of silica and calcium oxide are mixed up with a solution of sodium to calcium chloride and then burned.

HEINTZEL makes a hydraulic lime by mixing calcium hydrate with infusorial earth.

MAGNESIA CEMENT.

The hydraulic properties of magnesia were first noticed by MACLEOD and afterward by VICAT. ST. CLAIR DEVILLE was the first to study the subject thoroughly; he found that magnesia, burned at a red heat, behaved like alabaster, but if mixed with chalk it set to a stony hardness. If heated to a higher temperature its hydraulicity decreases.

If dolomite is burned until the magnesium carbonate, but not the calcium carbonate, is decomposed, the produce has very powerful hydraulic properties, but this is not the case if the calcium carbonate is converted into the oxide.

Similar results were obtained by CALVERT with the magnesian limestone of the Island of Anglesea, which may be made into good cements by a properly regulated burning.

The following table gives the composition of several of these limestones:

	1	2	3
Magnesium carbonate	61.15	55 20	15.86
Calcium carbonate	21 41	33.99	72.22
Calcium iron oxide	8.76	3.85	3.21
Silica	5.28	5.58	2.73
Alumina	2.07	2.27	
Organic substances and water	1.10	3.40	6.00

Of these, according to CALVERT, No. 1 resembles cement; No. 2, hydraulic lime; No. 3, stucco.

A dolomitic limestone containing 27 per cent. magnesium carbonate and 50 per cent. calcium carbonate is found near Jena, and hydraulic lime is made from it. These limestones are utilized in this way in many places, but the cements made from them are not nearly as hard as Portland cements. They usually have a tensile strength of 5 to 10 kgr. per sq. c. m., while a good Portland cement should never give less than 10 kgr. per sq. c. m.

These cements contain 50 4 per cent. calcium oxide, 20 per cent. magnesia, 11.1 per cent. sesquioxide of iron and 17.1 per cent. silica, and are not really magnesian cements, but a mixture of them with ordinary hydraulic lime, and it will be readily understood that the magnesia cement has its best effect owing to the high temperature required for some of the materials.

SOREL is the inventor of another class of magnesian cements, which are made by treating burned magnesia with a solution of magnesium chloride of a density of 20°-40° Baume, producing a substance that is especially adapted to making artificial stones. The Union Stone Co., of Boston, manufactures artificial stones on a large scale by this process. A magnesian carbonate found in Pennsylvania and Maryland containing 95% $MgCO_3$ and some insoluble silica, is carefully burned, and then ground to an exceedingly fine powder; this is mixed with powdered marble, slates, etc., and made into a plastic mass with a magnesium chloride solution of a density from 15° to 20° Baume. It is then moulded into the form required. In a week after being taken from the moulds it is so hard that it has a tensile strength of from 500 to 1,500 kgs. per sq. c. m.

REINHARDT manufactures artificial stone at Wurzburg (mantels, grind stones, mill stones, artificial ivory, artificial marbles, etc.), by mixing up burned magnesia with magnesium chloride. KUNIS produces the magnesium chloride by treating some of the magnesia with hydrochloric acid.

In one of SOREL's processes the magnesia is mixed with magnesium sulphate.

Albolith is a mixture of magnesia, magnesium chloride and amorphous silica, although the latter really acts as sand.

Cajalith is also essentially a cement mortar.

According to HAUENSCHILD ordinary magnesia cement consists of irregular rhomboidal crystal. On mixing with water the burned magnesia takes up water crystallization and crystallizes, binding the whole mass together and making it very hard.

An excess of water would be absorbed by capillarity, and would disintegrate the whole mass; accordingly just enough water should be used to insure complete crystallization.

After long exposure part of the magnesia is converted into the carbonate, thus increasing the hardness of the material.

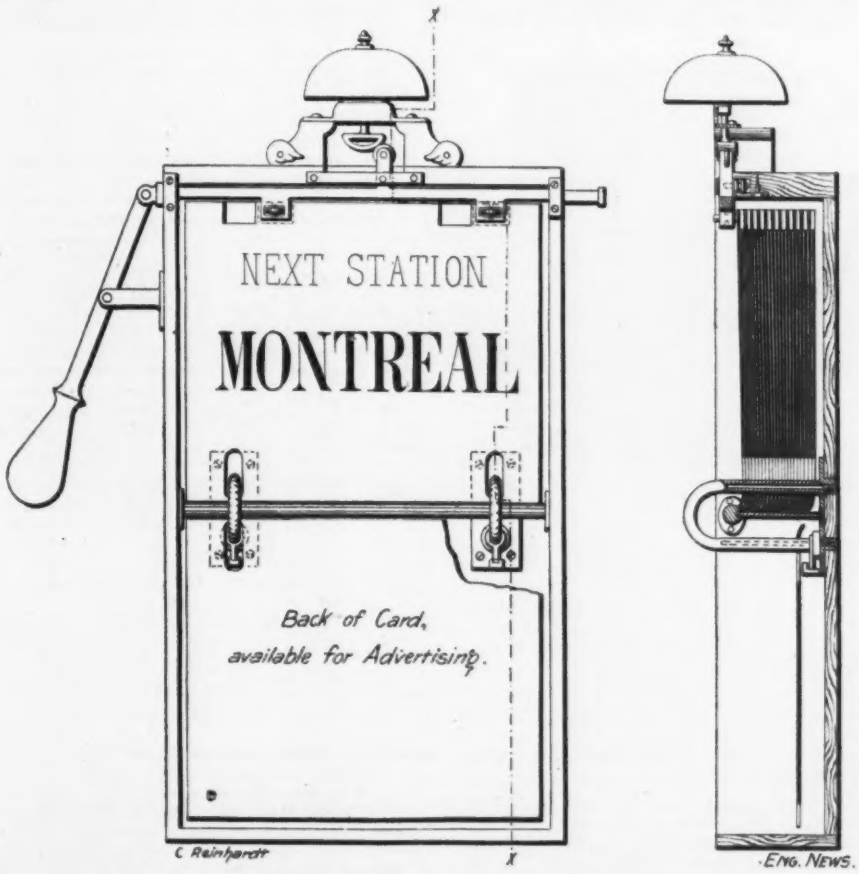
According to BENDER, the hardening of cements containing magnesia and magnesium chloride, is due to a union of magnesia, magnesium chloride and water. ($5\,MgO + MgCl_2 + 17\,H_2O$). At 100° this gives up 9 molecules of water of crystallization. At 180° 11 molecules. Part of the $MgCl^2$ may be dissolved out by cold water, and all of it with hot water, but this does not disturb the union of the cement. These cements absorb considerable CO_2. KRAUSE obtained the salt $10\,MgO + MgCl_2 + 10\,H^2O$ by the action of magnesium chloride on magnesia, and claims that on exposure to the air a mixture of this salt with basic magnesium carbonate is formed.

The Allison Station Indicator.

We illustrate this week a station indicator for railway cars which is intended as an improvement on the prevailing system of having the names of stations announced by the brakeman of each car. This verbal system is unsatisfactory in many ways, and various forms of mechanical indicators or annunciators have been designed; some worked simultaneously throughout the train and others worked automatically from the track.

The Allison indicator is very simple in construction, and is operated by the brakeman of the car. It consists of a frame about 22 ins. high and 17 ins. wide, varying in depth according to the number of stations on the route and the consequent number of cards. Within the frame is a set of plates of thin iron, japanned, 11 × 16 ins., which can be packed 35 to the inch; they are strung by holes near the bottom upon two hollow iron staples, which are fitted over pins secured to the back of the casing, so that the cards can easily be put in position. At the back of the plates, and occupying a depth of only ½ in., is a stiff plate with four springs behind it, one at each corner, by means of which they are pushed forward. The plates are held in place by two lugs or projections on the sliding bar at the top of the indicator, which projections lie against the face of the outer plate. Each plate has two slots in its upper edge, and the plates are arranged so that the slots will be alternately to the right and left of the projections on the bar; thus only one card can fall at a time. The brakeman alternately pushes and pulls the lever at the side of the frame, causing the bar to move to the left or right, and bringing the projections on this bar opposite the slots on the outer plate, which is then thrown forward by the springs and falls over, exposing the rear face, which may be utilized for advertising purposes. The movement of the lever also sounds the gong on the top of the frame by means of the small arm and roller on the bar, which elevate the spring hammer. The machinery is said to cost $16 for the two indicators in each car. The plates cost about 50 cts. each.

This indicator is manufactured by the Allison Co., of Montreal, Canada. The company has a contract to equip all the passenger cars of the Grand Trunk Ry., and has already fitted all the first-class cars on the division between Montreal and Toronto.



THE ALLISON STATION INDICATOR.

Department of Public Works of Philadelphia; Staff and Salaries for 1890.

As the question is frequently put to us regarding the salaries paid and the number and duties of officers having charge of the public works of large cities, we make the following abstract from the last annual message of Mayor E. H. FITLER, of Philadelphia. These amounts are taken from the annual appropriations and cover all the officials connected with the Department of Public Works, and under its head the "Director" of this department:

Main Office.—Director, $7,500; chief clerk, $2,000; clerk, $1,000; stenographer and typewriter, $900; stenographer, and clerk, $900; messenger, $720; horse and carriage, $500; printing, stationery, etc., $1,500. Total, $15,020.

Gas.—Chief of Bureau, $5,500; assistant to chief and general storekeeper, $3,000; general superintendent, $2,500; general bookkeeper, $2,500; 3 chief clerks, $2,000 each; registrar and chief meter inspector, $1,800; 3 superintendents of work, $1,800 each; general clerk, architect and draftsman, general foreman, $1,500 each; chief transfer clerk, $1,320; with a large number of smaller offices. Total salaries, $157,768.

Highways.—Chief of Bureau, $3,500; 5 assistants and one superintendent of bridges, each $1,800; chief clerk, $2,000; assistant and contract clerk, each $1,000; license clerk, $1,170; bill clerk, assistant and stenographer, each $1,000; janitor and clerk, $720; 10 inspectors, each $900; inspector of sewer repairs, $1,200; office boy and messenger, $500; 2 yard watchmen, each $600. Total salaries, $34,090.

Lighting.—Chief of Bureau, $1,800; clerk, $1,000; 5 district superintendents, each $900. Total salaries, $7,300.

Street Cleaning.—Chief of Bureau, $2,500; 5 inspectors, each $1,000; clerk, $1,000; messenger, $920. Total, $9,220.

Surveys.—Chief engineer and surveyor, $4,000; principal assistant engineer, $2,250; assistant engineer, $1,800; recording clerk, $1,500; draftsman, $1,500; sewer registrar, $1,500; draftsman, $1,250; 2 draftsmen, each $1,000; sewer clerk, $1,000; stenographer and typewriter, $850; rodman, $720; janitor $600; registry clerk, $1,100; 5 draftsmen, each $1,000; 3 draftsmen, each $800. Total salaries, $29,720. In addition to these amounts Philadelphia appropriates $64,205 to district surveyors—provided "that the fees earned in each district shall amount to the salaries, over and above the expenses of the office."

Water.—Chief of Bureau, $5,000; chief clerk, $2,000; assistant clerk, $1,680; correspondence clerk, $900; time-clerk, $900; messenger, $650; draftsman, $1,800; draftsman, $1,000; draftsman, $900, general superintendent, $3,500; clerk, $900; assistant clerk, $850; assistant to chief, $2,000; clerk, $1,000; assistant clerk, $900; pipe inspector, $1,200; pipe clerk, $850; assistant to chief, $1,200; search clerk, $1,100; assistant search clerk, $900; chief inspector, $1,100; 19 inspectors, each $900; permit clerk, $1,080; assistant permit clerk, $1,000; purveyor, $1,600; 5 purveyors, each $1,480; 6 purveyor's clerks, each $720; general foreman, $939; superintendent of shops, $1,500; 6 engineers, each $1,000; 4 engineers, each $950; many minor positions not enumerated here. Total salaries $177,053.

These employees are generally paid monthly; though those in the Bureau of Gas and certain men in the Water Bureau are paid semi-monthly.

Patrol vs. Machine Street Cleaning to be Tested.

The machine and patrol systems of street cleaning are to be practically tested in New York by advice of the advisory commission on street cleaning. The districts have been allotted, and the experiments are to continue for 30 days at least. District *A* is to be cleaned entirely by hand in the day time, and District *B* entirely by machines in the night time.

The basis of experiment in the first district for February is 175 loads per day of ashes and garbage, to be removed by 24 carts making 7 and 8 trips per day. The district contains about 16 miles of streets and 5 men to the mile are estimated as necessary to keep it clean, or in all 82 men will be required. Each man would be provided with a broom, hoe and shovel; carry a conspicuous badge; have a district range allotted to gangs; and to work from 7 A. M. to 6 P. M., excepting one hour for dinner. They must be at work all the time sweeping the dirt into piles along the curbstone; these sweepings are to be gathered as rapidly as possible into iron cans, preferably mounted on wheels. The contents will then be removed by carts, taking about 70 loads of street sweepings as estimated daily from this district. The carts are to follow specified routes. Each cart is to be at its post at 7 A. M. and work until 6 P. M.

For the district *B* the ashes and garbage are to be removed as above and with the same number of carts. For cleaning the 16 miles of streets in this district two sprinkling machines and four double sweeping machines will be detailed. Work is to commence at 9 P. M. and proceed according to a fixed programme of routes. The dirt, after being swept into the gutters, is to be collected into piles by a special machine lately introduced for this purpose; or in case this machine does not work well the dirt is to be gathered in piles by 14 men following closely behind the sweepers. These piles should be removed by 10 carts, which should leave the stables by 10 P. M. and follow closely behind the sweepers, 5 carts to each gutter. No hand sweeping is to be done in this district in the daytime. The ashes, garbage and street sweepings, in both cases, are to be disposed of as at present, in scows at designated wharves.

Legal Decisions of Interest to Engineers.

Responsibility for Defective Drainage.—A railroad company which constructs a ditch near a dwelling house so that water collects therein and becomes stagnant is liable in damages to one whose health is injured thereby, though he be but a tenant in possession. (Lockett v. Ft. Worth & R. G. Ry. Co., Supr. Ct. Tex., 14 S. W. Rep., 564.)

Injury of Postal Clerk.—A government postal clerk while riding upon a railroad train in the performance of his duties and under a contract between the company and the government providing for his transportation as a passenger. So far as the responsibility of the railroad company to safely carry him is concerned, where permanent and lasting injuries of a serious nature are proved, a verdict for $5,000 cannot be said to be excessive. (Mellow v. Mo. Pac. Ry. Co., Sup. C., Mo., 14 S. W. Rep., 758.

Accident at Highway Railroad Crossing.—The rule of law in reference to personal injuries in railroad accidents is that, although the servants of the company are shown to have been negligent, the person injured cannot recover if by the exercise of ordinary care he could have avoided the consequences of the company's negligence. Where a person testifies that he was injured by a train in the daytime at a place where he could have seen a train 400 yards distant, he cannot recover, although he testifies that he looked and listened and neither saw or heard a train. (Atlanta & West Point Ry. Co. v. Loftin, Sup. Co., Ga., 12 S. E. Rep., 195.)

The Flood of June, 1889, in the West Branch of the Susquehanna River.

The extent of the great storm which on May 31 and June 1, 1889, caused such loss of life and property in the States of Pennsylvania, Maryland and New York has hardly been generally realized. At that time, the appalling destruction at Johnstown drew universal attention to the Conemaugh valley, although the rainfall was no heavier there than at many points in the eastern part of Pennsylvania. It may be remembered, however, that at points on the Upper Susquehanna, the reports as to the loss of property and life rivaled at the start those from the Conemaugh valley; and had it not been for the far greater calamity along the latter stream, the floods at Williamsport, Lock Haven and other points on the treacherous Susquehanna would have been ranked as among the greatest of American flood disasters.

An examination of the West Branch of the Susquehanna has recently been made by Major CHAS. W. RAYMOND, U. S. Engrs., nominally with a view of determining the feasibility of improving the river for navigation, but really to investigate possible means of controlling floods in the river. The following is an abstract of his report:

The accompanying map shows the water-shed, nearly 6,900 sq. miles in extent, which is drained by the West Branch of the Susquehanna. It extends from a point near Sunbury, where it meets the North Branch of the Susquehanna, north and west to a point in Clearfield Co. Sunbury is about 125 miles from the mouth of the river at Havre de Grace and the same distance from the head of the West Branch. The slope of the portion of the river from Sunbury to the sea is very variable, but averages 3⅓ ft. per mile. From Sunbury to the head of the West Branch, 125 miles, the fall is 415 ft., divided as follows:

Locality.	Distance, miles.	Elevation above sea level, ft.	Slope, ft. per mile.
Sunbury	0	430	...
Muncy	23	469	1.7
Williamsport	16	498	1.8
Jersey Shore	15	508	0.7
Lock Haven	13	550	3.2
Whetham	15	619	4.6
Keating	22	700	3.7
Head of West Branch	10	845	7.2

The slopes of the main tributaries of the West Branch for which levels are obtainable are as follows:

Clearfield, 14 to 20 ft.; Sinnamahoning, 7 to 19 ft.; Bald Eagle, 12 to 18 ft.; Pine, 9 to 20 ft.; Lycoming, 12 to 20 ft.

At extreme low water the discharge of the West Branch may fall to 800 cu. ft. per second at Williamsport, and 1,000 cu. ft. at Northumberland, where it meets the North Branch. Mean low-water discharge is about double this, or about 0.28 cu. ft. per second per sq. mile of drainage basin. Dams for water-power purposes (of the following heights) are located at Lock Haven (11 ft.), Williamsport (10 ft.), Muncy, (7 ft.), Lewisburg (3 ft.), and Sunbury (8 ft.).

FLOODS OF THE RIVER.

Two great floods have occurred of which the heights have been recorded. We quote from the report as follows:

Locality.	Total distance, miles.	Elevation above ordinary low water, ft. March, 1865.	June, 1889.
Sunbury	0	..	....
Northumberland	8	20	18
Muncy Dam	31	30	37
Williamsport	49	27	33½
Lock Haven	75	14	18
Clearfield	..	10	17

The flood of 1865 was caused by the rapid passing away of a large accumulation of snow and ice after a severe winter, and its amplitude was probably increased by ice gorges.

The flood of 1889 exceeded all preceding flood limits, and was due to the heavy rainfall of May 30 to June 1. Although the storm was widespread, extending from Kansas to the Atlantic coast, the heaviest rainfall was confined to a belt about 150 miles in width, extending across the middle of Pennsylvania, with its axis slightly east of north. Within this belt from 4 to 9 ins. of rain fell during the 36 hours' duration of the storm. The heaviest precipitation was upon the high table lands of the water-shed of the west branch of the Susquehanna.

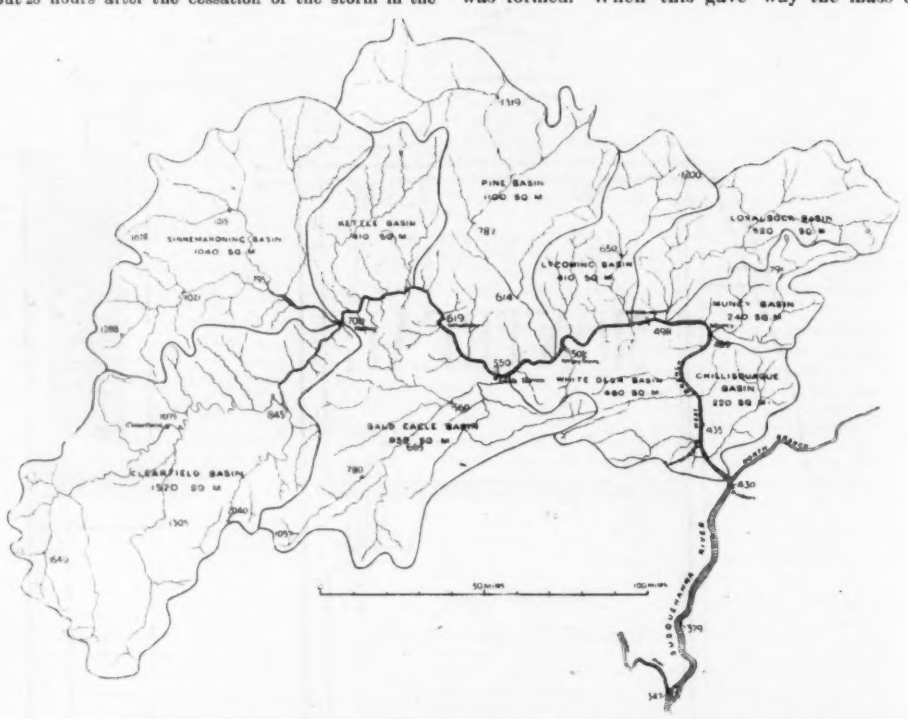
The principal parts of the cities of Lock Haven and Williamsport were inundated to a depth of from 4 to 8 ft. The loss of life in the counties bordering the West Branch was 78, and the disbursements of the Flood Relief Commission to the sufferers within this district aggregated nearly $300,000.

So far as relates to the basin of the West Branch of the Susquehanna, the storm began about the middle of the southern line of the water-shed, and in about 11 hours it had extended across the basin to its northeastern limits. The average duration of the rainfall was about 34 hours, and its mean depth, as determined by observations at 14 points on or adjacent to the water-shed was 6.65 ins.

The following gives an idea of the rate of progress and rise of the flood.

Locality,	Distance, miles.	Time of highest flood.	Height, feet.
Lock Haven dam	0	June 1, 4 P. M.	18
Williamsport	26	June 2, 1 A. M.	33½
Muncy Dam	44	" "	37
Northumberland	67	June 2, 9 A. M.	18

The area of the water-shed above Lock Haven is about 3,000 sq. miles, or nearly one-half the area of the entire basin. The water-shed discharging at Williamsport is about 4,500 sq. miles; at Muncy Dam, about 6,000 sq. miles; and at Northumberland, 6,800 sq. miles. The storm in the southwestern, western and northwestern parts of the basin began about 5 P. M., May 30, and by 4 P. M. June 1, or 47 hours thereafter, the flood had attained its maximum height at Lock Haven. This maximum was reached about 28 hours after the cessation of the storm in the western limits, and 4 hours after its cessation in the eastern limits of the basin. On June 5 the principal volume of the flood had passed away and the river had fallen nearly to the plane of common high water.



MAP OF WATERSHED OF WEST BRANCH OF SUSQUEHANNA RIVER, PA.

In a mountainous country, such as forms the water-shed of the West Branch of the Susquehanna, it may be assumed that at least 50% of an ordinary rainfall reaches promptly the recipient of the basin. The rate of infiltration and absorption of rainfall will, upon the same area, be quite constant, consequently the percentage of loss by infiltration must be less in excessive than in ordinary precipitation.

In such a rainfall as caused the flood of 1889, where the precipitation was over 6 ins. in 34 hours, or from four to five times greater than the quantity which falls in an ordinary heavy rain, it is probable that 75% of the rainfall may reach the outlet of the basin.

The area of the watershed of the West Branch of the Susquehanna is about 6,900 sq. miles. The average rainfall upon the basin between May 30 and June 1, 1890, was over 6 ins. Upon the assumption that 75% of this rainfall reached the outlet of the basin, the aggregate discharge was 72,135,360,000 cu. ft.

No observations are available to determine the discharge of the lower trunk of the West Branch during any period of the flood, but it may be of interest to compare its probable flood stage with the low-water stage of the river.

The low-water discharge of the West Branch may be assumed at 1,000 cu. ft. per second, or 86,400,000 cu. ft. per day. It has been previously determined that the discharge of the river during the continuance of the flood was about 72,135,000,000 cu. ft., and since the estimates of various observers assign about one week for the flood stage of the river, the mean daily discharge during this interval was about 10,300,000,000 cu. ft. per day, or about 120 times the low-water discharge of the river. How much the maximum discharge during the flood period exceeded the mean can not be determined.

The report then reviews the causes which increase the destructive effect of floods. The most important cause is the destruction of the forests. It is stated that in forests, four-fifths of the precipitation is absorbed or detained by the spongy soil, to be gradually given up in springs and gentle rills. On the same slopes and surfaces denuded of their forests, four-fifths of the precipitation runs off immediately, and only one-fifth is absorbed by the soil.

Bridges, dams, and other artificial obstructions interfere with free flood discharge. Piers and abutments reduce the cross-section, especially as structures are generally located where the natural banks are narrowest. The approaches to bridges often act as dams to prevent the flood relieving itself by passage at the ends of the bridge. The bridge structures themselves, on the West Branch, were placed at such an insufficient height that the drift and wreckage accumulated until a temporary dam was formed. When this gave way the mass of water, logs, trees and timber descended in a rushing wave to destroy similar structures below.

Another cause contributing to the destructive effect of floods is the collection of logs, lumber or ice in the stream. When the available water-way at bridges or other narrow points is taxed to its full capacity, logs and lumber passing down with the flood are sure to form a jam; no possible provision of man can remove the danger from ice gorges when floods occur at a time when the stream is covered with heavy ice. The removal of ice is all that can be done.

METHODS OF PROTECTION AGAINST FLOODS.

These are summarized as follows: (1) Maintenance and planting of forests at the headwaters and upon the upper slopes of the basin, (2) storage reservoirs, and (3) transverse barriers carried across the lines of drainage, which will moderately store or check the passage of the flood volumes and hold in the ravines the materials detached by scour. The methods of control are as follows: (1) Longitudinal embankments to retain the flood volume as nearly as possible within the limits of the natural channel. (2) Barriers constructed at rocky gorges on the larger tributaries to reduce the widths of the streams so as to regulate the times of arrival of their floods in the main channel. (3) Increase of the dimensions of the channel. (4) Removal of the causes of temporary obstructions.

Forest planting as a method of prevention of floods has been carried out with wonderful succes

in France, Italy, Germany and Austria. The storage reservoir plan requires to make it feasible, suitable, sites for reservoirs and dams, which can be given up to be flooded at no great expense. Such dams could not be utilized for water powers, since their efficiency in preventing floods depends on their reservoirs being empty except during flood stages of the river. The method of prevention by transverse barriers has generally been carried out by placing at very numerous points on the minor tributaries of the stream rough piles of rocks or boulders, which on the larger tributaries become permeable dams of rock or brush. In the valley of the Ubaye, a small tributary of the Rhine in southeastern France, there have been built, on a water-shed of 400 sq. miles, 71 main dams and 2,916 rustic dams. The total cost of these works to Dec. 31, 1887, was about $553,000.

Controlling floods by longitudinal embankments or levees is the oldest as well as the most common means of protection. The chief defects of the system are the great expense, both of first cost and of maintenance, and the serious damage which is caused when occasional ruptures occur. In streams carrying large amounts of solid material at flood stages a filling up of the river bed may follow the construction of levees, raising the river bed above the level of the surrounding country and necessitating the continual raising of the levees. Barriers at rocky gorges to delay the passage of a flood can only be employed under peculiar and rare conditions. Doubtless something can be done for the control of great floods by increasing the dimensions of the natural channel and removing obstructions in the shape of rocks and shoals, but complete control by this method is generally impossible.

The report then discusses the applicability of the above methods to the control of floods in the West Branch. The storage reservoir plan is out of the question on account of its enormous cost, and practically the same reason operates to make both longitudinal and transverse barriers impracticable. All that can be done at present is to do away with obstructions to the main stream by bridge and boom piers, remove leaning trees and drift from the banks, and, most important of all, prevent the removal of such forests as still remain on land not valuable for cultivation, especially those near the headwaters and on the steeper slopes of the water shed.

An English Pipe Joint.

We illustrate herewith a new pipe joint which has become very popular in England, especially in the mining districts, both because of its cheapness and excellence, and is rapidly coming into use also in South Africa, Australia, South America and other countries.

The construction of the joint is shown in the accompanying engraving. Fig. 2 shows a sectional view. The lengths of pipe are slightly expanded at the ends and a cast-iron ferrule is slipped between them. On the pipe are loose flanges with their inner surfaces inclined to fit the expanded end of the pipe. Bolts through these flanges draw the pipe ends together and press them tightly against the ferrule, making a tight joint. Fig. 3 shows one of the ferrules with packing rings. It will be seen that the packing is closely confined in the annular grooves of the ferrule when the latter is in position, and it is impossible for it to be blown out by internal pressure, as sometimes happens with ordinary flanged pipe.

The ferrule is made of cast iron and is used just as it comes from the foundry, so its cost is very small. The packing rings used are generally of lead, but for special purposes are also made of gutta-percha, india-rubber, asbestos or other materials. The amount of packing used is so small that its cost is very moderate. The joint is in use on tubes of 2 ins. internal diameter and larger. It is especially advantageous for connecting very thin tubes, as it avoids the weakening which results from cutting a screw thread or fastening on flanges by riveting, so by its use tubes made from lighter gage sheets can be used for heavy pressures.

It is, so far as we recall, the only joint which permits the pipe lengths to be connected at a considerable angle, as much as 1 in 20, or moved out of line after bolting up. This is an especially valuable feature for mining work or for lines of pipe for temporary purposes. The joints can be made more easily and rapidly than screwed joints even. In putting up vertical lines of pipe the loose flanges greatly facilitate the work, as the length of pipe does not have to be turned, as with ordinary flanged pipe, to make the bolt holes on the two lengths coincide. The pipes bear their own weight in the shaft and require very little bracing. A length can be removed or replaced from a long line without disturbing the line.

The expanding of the ends of the pipe is done either at the time of manufacture or at the place where the tubes are to be used. It can be done by a blacksmith over a forge fire more easily than a thread could be cut on the pipe for a screw joint. The expanded end of the tube is not machined at all, nor is any attempt made to expand the tubes with any great accuracy. They are simply made to cover the shoulder of the ferrule approximately, and when the joint is screwed up the pressure of the bolts and flanges draws the tube end down against the ferrule.

This joint is said to be cheaper than any other on the market for pipes above 2 ins. diameter, and it has given great satisfaction when used under peculiarly trying conditions. Pipes connected by it have stood pressures as high as 4,000 lbs. per sq. in., and are in use for conveying steam, water and compressed air. They would seem to be especially well adapted for petroleum pipe lines and also for the joints in copper steam pipes in marine service. For pipes subject to heavy pressure combined with much jarring and vibration the joint promises better satisfaction than any other, for the packing cannot blow out and jarring out of line does not affect the tightness of the joint. Any further information regarding this joint can be obtained at the office of this journal.

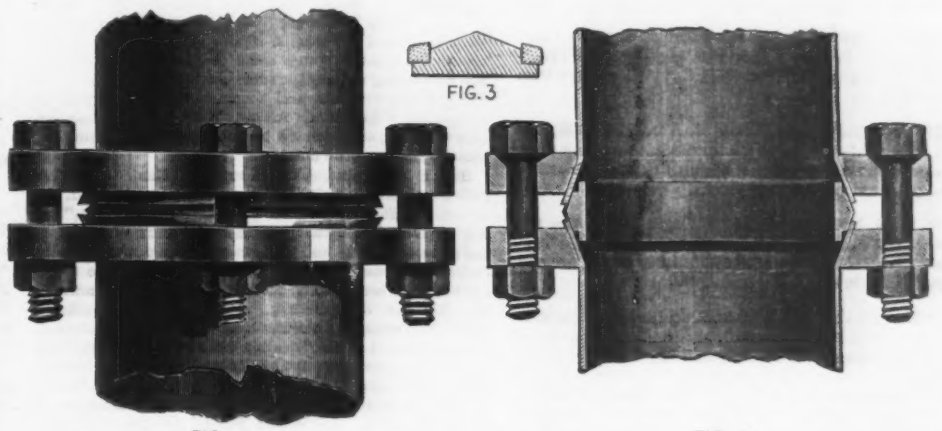


FIG. 1. FIG. 3 FIG. 2.

AN ENGLISH PIPE-JOINT.

Bad Street Pavements Waste Money.

The street paving question is chiefly an economic question. It is in some degree a sanitary question, and a question of comfort and convenience, but in its most important aspects it involves consideration of the waste of effort and the saving of expenditure. A manufacturer who should find that he was burning under his boilers three times the quantity of fuel necessary to give him the desired power would not long hesitate to address himself to the task of correcting the fault. But bad pavements, such as those which cover nearly all the streets of this city, are power wasters of a kind closely resembling a badly constructed fire-chamber. The sole purpose for which pavements are constructed is that resistance to locomotion may be reduced. This means reduction of the amount of effort required to move a load. Any effort costs something, and so the smallest effort costs least; and, therefore, the smoothest pavement saves most money to every man who traverses it with a vehicle. Just how much power is required to move a load upon a certain kind of pavement can be ascertained with as much exactness as any other fact; and it is asserted by those who have tried the experiment that the load which may be moved by two horses upon a smooth pavement will require about fifteen horses to move it upon an ordinary cobblestone pavement. If this be true, then somewhere about six out of every seven draft-horses used in Philadelphia represent clear waste. That is to say, so far as horses are concerned, every man who puts a wagon upon our streets wastes six-sevenths of the cost, because we have the wrong kinds of pavements.

Few persons, perhaps, realize the greatness of the dimensions of this loss. The street traffic of a city like Philadelphia has vast proportions. Probably the total amount of material moved in a year exceeds that transported by many railroads of considerable importance. What the exact cost of such movement is may not be easy to determine, but the estimate which places it at $15,000,000 would appear to be not unreasonable. If it be correct, and if the proportion of waste given above be not exaggerated, then we have as a part of the annual cost to the business men of this city of the barbarous pavements which we permit to exist a sum approximating $12,000,000. If it be urged that the waste is reduced to some extent by the use of the car tracks by ordinary vehicles, the answer is that this may be offset by the great loss caused by the wear and tear of vehicles and the injuries done to horses by the bad pavements. In this view of the matter it will be seen that the improvements of Philadelphia street pavements is a matter of large concern to the people. We throw away every year enough money to repave in the right manner a large portion of the town.

One obstacle to the reform is the practice which places the cost of repaving upon the owner of the property fronting upon the street. This looks like justice, but the public highway is for all the people, and, in any case, the system which puts the burden upon the individual tends to blockade any movement toward better things. The man who will gain the largest advantage from good pavements is the man who owns a wagon. If reform will save him money, as certainly it will, there would appear to some propriety in requiring him to help to effect it. A small tax upon vehicles and horses, a wheel and hoof tax, would produce a very large sum of money annually in Philadelphia. If there could be some assurance that it would be devoted wholly to improving the streets upon scientific principles, one street at a time until all were well paved, there would probably be little objection to payment of the tax by owners of wagons. That seems to us a practicable way, and a just way of attaining the desired end.

But no such tax should be levied until a determination shall be had of the identity of the best pavement. In our opinion, every kind of stone block should be ruled out at the start, excepting for places where there is a heavy inclination of the street surface. A good deal is to be said in favor of the smooth blocks made of asphalt and gravel. There is also just now, here and in Europe, much contention for the superior excellence of pavements made of wooden blocks. In the particulars of noiselessness and absence of slipperiness there can hardly be any doubt that this is the best of all coverings for a street. But the question of its durability is still an open one; and there is the further very important question whether there may not be objections upon sanitary grounds, for the reason that the filth of the highway will tend to saturate blocks which must be set with the grain in a vertical position. There is plenty of room here for experiment and for discussion. Sheet asphalt is objected to by many persons because of its slipperiness in certain conditions of the atmosphere. But for this, surely it would be the ideal pavement, for not only is it the smoothest of all, but it is practically watertight, and no filth can penetrate it. This pavement has fallen into disfavor in Europe, but it is only fair to urge that the European asphalt is almost wholly composed of limestone, so that the surface becomes very hard. The asphalt used in this country, on the other hand, is nearly pure pitch. The practice is to mix it with one part asphalt to three parts sharp sand. Whether a better foothold could be given to horses by a larger admixture of sand, or by the insertion of some other material, is debatable. The matter ought to be examined in the most thorough manner by competent and disinterested experts. The manufacturers and merchants of this city ought to see to it that the subject is explored in just that manner, and then they might profitably undertake to urge upon the city government the adoption of a general plan of reform.—*The Manufacturer.*

Missouri Pacific Railway Bridges.

(WITH INSET.)

We give this week an inset sheet illustrating an unusual type of bridge built by the Missouri Pacific Ry., from plans prepared by Mr. GEO. H. PEGRAM, Consulting Engineer. About twenty of these bridges have been built during the past year, the spans being 100, 150 and 200 ft. In ENGINEERING NEWS for Dec. 10 and 17, 1887, will be found a complete description of the peculiarities of design, computation and construction of these trusses, prepared by Mr. PEGRAM.

PERSONALS.

Mr. F. M. HOGE has been elected City Engineer of Wheeling, W. Va.

Mr. L. L. GERRY has been re-elected City Civil Engineer of Dover, N. H.

Mr. ELMER CLARK, Superintendent of the Kansas City Cable R. R. Co., was run over by a cable car and killed Feb. 4.

Mr. HUNTER MCDONALD, of the Nashville, Chattanooga & St. Louis Ry., has been appointed Chief Engineer of the Western & Atlantic R. R., vice Mr. EBEN PARDON, deceased.

Mr. PALMER C. RICKETTS, M. Am. Soc. C. E., has been appointed engineer of the Public Improvement Commission, Troy, N. Y., and Mr. GARNET D. BALTIMORE has been appointed assistant engineer.

Mr. H. G. KELLEY, Resident Engineer of the St. Louis, Arkansas & Texas Ry., with headquarters at Texarkana, Tex., will, in addition to his other duties, assume charge of the Bridge and Building Department.

Mr. HENRY C. WILLIAMS is President; Mr. PHILIP E. RAQUE, Vice-President and Engineer; Mr. F. S. HARRISON, Secretary and Superintendent; and Mr. F. T. YOUNGS, Treasurer, of the Atlas Iron Construction Co., Times Building, New York City, which has been organized to carry on an engineering and contracting business, making a specialty of structural and architectural iron work.

Capt. EDMUND BERKELEY, Superintendent of the Atlanta & Charlotte division of the Richmond & Danville R. R., has been appointed Superintendent of the R. & D. main line. Mr. C. P. HAMMOND, Superintendent of the Georgia Pacific Ry. Division, will succeed Capt. BERKELEY, and Mr. W. B. RYDER, formerly General Superintendent of the Chesapeake & Ohio Ry., will take charge of the Georgia Pacific.

Mr. WILLIAM E. WORTHEN, Past President Am. Soc. C. E., and now Chief Engineer of the Chicago Drainage Board, is to receive for his services in the last-named office a salary of $10,000 for one year from Dec. 17, 1890. If his employment shall cease on or before June 1, 1891, Mr. WORTHEN is to be paid at the rate of $1,000 per month. By the same resolution of the board Gen. JOHN NEWTON is to receive $10,000 per year as consulting engineer.

Mr. JACOB N. MCCULLOUGH, First Vice-President of the Pennsylvania Co., which controls the leased lines of the Pennsylvania R. R. west of Pittsburg, died at Pittsburg, Pa., Feb. 8, aged 70 years. In 1858 he became president of the Cleveland & Pittsburg R. R., then in a very poor condition, and succeeded in making it a valuable property which became a part of the Pennsylvania system about 1868. In 1865 Mr. MCCULLOUGH became General Superintendent of the Pittsburg, Fort Wayne & Chicago R. R., and soon afterwards was appointed general manager of that road and the Pittsburg, Cincinnati & St. Louis R. R., which position he held until Jan. 1, 1874, when he was made First Vice-President of the Pennsylvania Co.

NEW PUBLICATIONS.

FEBRUARY MAGAZINES.

None of the February magazines contains any technical articles of especial interest or novelty. The *Century* has a vivid sketch of "The Georgia Cracker in the Cotton Mills," which will be a revelation to most readers of the peculiarities of one class of Southern laborers, despite the general knowledge of the existence of a class of "poor white trash" in the South. It has also two very interesting articles on the discovery of gold in California. We also have in "Colonel Carter of Cartersville" as charming a sketch as can be found in literature, it seems to us, of one of the oldest and simplest of railway boomers. We are glad to be able to make out this much connection between the story and engineering, in order to find some excuse for noting its unusual literary merit.

The *Atlantic* contains some recommendations as to "The Next Stage in the Development of Public Parks," by the addition of fresh and salt water aquariums, zoological and botanical gardens, etc., with which we fully sympathize. There is abundant opportunity for the giving of great pleasure to all and of useful knowledge to many, at comparatively small expense, by the addition of such features to large parks, and the time cannot be far distant when it will be done on a much larger scale than is as yet known to this country, or even to Europe, which is distinctly in advance of us in this respect.

The most interesting article in the *Popular Science Monthly* is a stolen one, as is too apt to be the case, on "The Aryan Question and Prehistoric Man," by Prof. HUXLEY. It presents too elaborate a theory of the conditions of one fraction of the human race in the remote past for us to attempt to abstract it. The article is "conveyed" from the *Nineteenth Century*. If the publishers would lift this monthly out of the slough of legalized theft of foreign articles in which it now wallows more or less, and make it a source of exclusively original information, they would speedily find, we believe, that honesty is the best policy, as our leading literary magazines have found. It contains one original article of very striking interest, however, on "Progress in Agricultural Science." It tends to show that the nutrition of plants is as much affected by bacterial conditions as are animal organisms. Some very curious experiments are detailed which seem to prove that sterilized soil containing exactly the same quantities of plant food as other non-sterilized soil becomes almost incapable of supporting vegetation. An original article on modern iron smelting, of which we have already made some abstracts, is also a good one.

Harper's contains, as usual, some excellent descriptive articles of strange and little known regions, Finland, the Straits of Magellan and "The Heart of the Desert," the last a vivid description by CHAS. DUDLEY WARNER of the more accessible and picturesque parts of the Colorado Cañon, the general character of which as a route for a railway has been lately described in these columns by Mr. ROBERT B. STANTON, with copious illustrations. *Scribner's* contains a similar article, and a very interesting one "About Africa," dealing more with the people than the country, however. It also contains a readable description of the meterological peculiarities of "Mount Washington in Winter," and the conclusion of a rather weak pot-boiler, called "The Water Devil," by Mr. FRANK R. STOCKTON, in which that versatile writer so violates all scientific possibilities known (and not probabilities merely) as to wholly destroy the amusing air of reality which he sometimes throws around the most unlikely situations.

—*A Descriptive Treatise on Constructive Steam Engineering*: Embracing Engines, Pumps and Boilers, and their Accessories and Appendages, by JAY M. WHITHAM, M. E., C. E., author of "Steam Engine Design." New York, 1891. John Wiley & Sons. 6 × 9¼ ins. pp., 900; 795 illustrations. $10.

The average technical book or technical paper produced by a college professor contains much theory and but little of the records of practical work. This is natural, for theory is at his fingers' ends, while examples from practice are hard to secure. From this point of view, therefore, Prof. WHITHAM'S word is to be highly commended. Notwithstanding his remote location "in the wilds of Arkansas" (he is Professor of Engineering at the Arkansas Industrial University), he has collected in this book practical data from almost every builder of steam engines or boilers in the country. The cuts used are very largely taken from manufacturers' catalogues, and a considerable part of the letter press is from the same source.

The author says in his preface: "This work treats of the constructive features of engineering. The subject of the design is not discussed." In other words, he has endeavored to write an encyclopedic work on the construction of all parts of a modern steam plant without poaching on the ground already covered by his work on "Steam Engine Design." To the ordinary man, not accustomed to hair splitting, this seems a distinction without a difference. The work before us will be of more use to the steam engine designer than to any one else. It takes up, for instance, the subject of crank shafts, gives nine figures illustrating different styles of crank shafts, describes the special features of some of them, and states the points requiring attention in the design of a crank shaft for different locations. So with pistons, valves, feed pumps, boiler settings and all other details. The book is, therefore, really a treatise on steam engine design, although it is defective in one point, namely, that not one of the illustrations carry a single dimension or a scale, and the author markedly avoids any discussion of the proportions of parts or dimensions. We suspect that this omission is made because of the distinction which the author has set up between the "design" of the steam engine and its "constructive features."

It may be said that the title of a book is of little moment compared with its contents. But the trouble is that a man is not apt to stick to his text unless he has a clear idea of its meaning. In this case "Constructive Steam Engineering" proved so elastic a subject that the author was enabled to include under it a chapter on "Heat and Steam," a very long one on indicators, planimeters, horse power gain by condensing, etc., several pages on belting and speed of pulleys, considerable matter on engine running and on engine and boiler trials, and one whole chapter and parts of some others from his own book on "Steam Engine Design," a topic which, in the preface, he agreed not to say anything about.

If all this matter and considerable more equally foreign to steam engine construction had been omitted, the publisher might have been able to put the price at some more moderate sum than $10, and the bulk taken from the volume would have been a gain. The work which the author put on this matter would have been much better spent in discussing more fully the different details of engines and boilers, for this part of the work is of much value and interest, and similar fresh and valuable matter is not to be found in any other of the multitudinous works on steam engineering which we now recall. Especially is the author to be commended for the pains he has taken to bring the work up to date, and describe all the latest appliances of proved value. Even such modern inventions as the steam loop, the latest Barrus calorimeter, petroleum fuel burners, several designs of separators, and Pedrick & Ayer's link motion model, are illustrated and fully described.

We must, however, find one word more of fault, which is the price. Considering how large a portion of the book is reprinted verbatim from trade catalogues, society proceedings and technical journals, and how many of the cuts were procured from the same inexpensive sources, the necessity of putting so high a price on the book is not apparent, and the wisdom of doing so is certainly open to question.

—*A Move for Better Roads.*—Essays on Roadmaking and Maintenance, for which prizes or honorable mention were awarded, through the University of Pennsylvania, by a committee of citizens of Philadelphia, with a synopsis of other contributions and a review by LEWIS M. HAUPT, Professor of Civil Engineering and secretary of the committee; also an introduction by WILLIAM H. RHAWN, chairman of the committee. Philadelphia: University of Pennsylvania Press, 1891. pp. 319.

We have already briefly commented on the good work done by the citizens' committee and the University of Pennsylvania, and we have given the list of contributors receiving prizes or honorable mention. The paper of HENRY IRWIN, C. E., of Montreal, deservedly received the first prize, and it is a concise, clear and most useful contribution from the construction standpoint, and is evidently the work of one who knows of what he speaks. Mr. IRWIN devotes little space to theory, but he gives figures and experience, which is what is wanted in such an article. His paper covers the whole practice of the making and maintaining of roads and streets, and goes very fully into detail; the table of construction prices, given on page 49, is an exceptionally useful work for purposes of general comparison and estimates. The one missing feature, that Mr. IRWIN could doubtless have put into excellent form, is that of a few illustrations. To the average reader, and for the purposes of these essays, pictures tell a story better and with more effect than pages of text. The text here leaves little if anything to be desired in clearness; but the writer of this text could have also given some very clear and useful diagrams and sketches.

The second prize paper, that of DAVID H. BERGY, B. Sc., M. D., of North Wales, Pa., is more of a general discussion of the subject; and while it contains very much that is valuable, it appears to be rather the work of a clear-headed observer and compiler of data than the result of personal experience in road making. As might be expected under these conditions, Dr. BERGY devotes more space than Mr. IRWIN to the economic features of the problem; the legal methods, taxation, control of work, etc. He very properly insists upon putting this work into the hands of competent engineers, and proposes for Pennsylvania a State Engineer of Roads, who is to control in all matters pertaining to roads and be at the head of the road department of the State.

Mr. JAMES B. OLCOTT, of South Manchester, Conn., in the third prize paper, sharply criticises some prevailing theories on the methods of building country roads. He would make his road of small broken stone; all spaces to be filled solid with the same material, "roof-tight and water shedding over dry foundations." Mr. OLCOTT wants to drain his road from the roof and not through the foundations. Broad-tired carts are also insisted upon; and the absurdity is pointed out of attempting to stuff "bottomless holes" with broken stone under the guise of road maintenance. While Mr. OLCOTT would permit rock of any reasonable size in his road, he wants all the coarse material below, out of reach of wheel friction, and made practically impervious to water and frost by filling all interstices with sand, gravel, etc. He is opposed to what he designates as the "honeycomb doctrine for roads."

Mr. EDWIN SATTERTHWAIT, president of a turnpike company, speaks from the standpoint of a manager of roads, and thinks that as the cost will for a long time prohibit

the introduction of the high class artificial road, more attention should be paid to improving our common roads by changing the present system of maintenance—so called "Working out road taxes" should be abolished, and responsible labor under competent supervision should be substituted for this antiquated and wasteful practice. Mr. SATTERTHWAIT gives much useful information on the materials for road making and their behavior under varying conditions.

Mr. CHARLES PUNCHARD, of Philadelphia, makes some striking comparisons of actual cases of road work, under the old and new systems, near Philadelphia. Mr. GEORGE B. FLEECE, C. E., of Memphis, Tenn., discusses grades, bridges, culverts, and then takes up road making proper. His "general suggestions" are good, and his first requirement, under the head of legislation, applicable is "to elect a competent engineer of roads and bridges." There are some objections to the "election" of this official that space will not permit discussion of here. Mr. FRANK CAWLEY, B. S., instructor of civil engineering in Swarthmore College, leaves to others the discussion of construction and practically confines himself to road management, township organization, methods in vogue and suggested remedies. He also points out the extreme value of the services of a competent engineer and defines his duties.

Prof. LEWIS M. HAUPT has done a good work in making a digest of the valuable points in those papers submitted but not published in full, and in this way puts on record much useful material, especially in the way of actual figures. In a series of "Notes" Prof. HAUPT reviews the entire series of papers, and presents in a concise and most useful form the general tendency of the several authors and a digest of their views. An apparently full index accompanies the work.

—*Report on the Preliminary Investigation to Determine the Proper Location of Artesian Wells within the 97th Meridian and East of the Foot Hills of the Rocky Mountains.* Mr. R. J. HINTON, Special Agent in Charge, 1890. Government Printing Office. Pamph., pp. 398 and about 40 maps, diagrams and illustrations.

This report is notable for its freshness and its valuable information. The act providing for the investigation reported upon was approved April 4, 1890, and the appropriation became available 10 days later. On April 16 Mr. R. J. HINTON, Washington, D. C., was appointed as Special Agent in charge, and Mr. E. S. NETTLETON, of the U. S. Irrigation Survey, as Supervising Engineer in the field, while about the same time Prof. ROBERT HAY, of Kansas, was appointed as General Field Geologist. Others were rapidly appointed to assist in the work, and on April 21 instructions were issued to field agents. The investigations over the large area covered were made, reported upon, and the general report compiled so that it was transmitted to the Senate by Hon. J. M. RUSK, Secretary of Agriculture, on Aug. 20, and the next day was ordered printed.

The volume under review contains the several reports of the gentlemen already named, and also those of the various field geologists and division field agents.

The reports of the field geologists relate to artesian and subterranean waters, artesian basins and their geology. The gentlemen named below reported as stated:

Prof. G. E. CULVER, of the University at Vermillion S. Dak., on the Dakota artesian basins; Prof. G. E. BAILEY, of the State School of Mines, Rapid City, S. Dak., on Southwestern South Dakota and Eastern Wyoming; Prof. L. E. HICKS, of the Nebraska State University, Lincoln, on Nebraska; Prof. P. H. VAN DIEST, C. E., Denver, on Colorado; Prof. E. T. DUMBLE, State Geologist of Texas, on Texas.

The field agents reported on the wells, artesian or otherwise, springs and subterannean waters of their respective divisions, as follows:

Mr. T. S. UNDERHILL, State Railway Commissioner, on North Dakota; Prof. S. G. UPDYKE, of the State Agricultural College, Brookings, on Southeastern South Dakota; State Irrigation Engineer F. F. B. COFFIN, of Huron, on that portion of South Dakota east of the Missouri River and north of 44° 13' north latitude; Mr. J. W. GREGORY, Garden City, Kan., on Western Kansas, Nebraska, Indian Territory, and other parts of the central division generally; Prof. L. P. CARPENTER, Professor of Irrigation, State Agricultural College, Fort Collins, on Eastern Colorado and New Mexico; Mr. F. E. ROESLER, Dallas, on Texas west of 97° longitude. In addition to Mr. COFFIN'S report (and in connection with him) Mr. HORACE BEACH reported on the finding of artesian wells in the Dakotas. Among the illustrations in the report are views of flowing artesian wells at Woonsocket and at Huron, S. Dak., in the San Luis Valley, Col., at Battle Mountain, Nev., Tulare and Delano, Cal., and elsewhere. Three large sectional maps show the region investigated and, by symbols, the location of wells, springs, lakes, ponds and pools. The map showing the southern area is on a scale of 20 and the other two maps of 15 miles to the inch. Smaller maps show less extensive sections of the country. Diagrams and sections accompany and elucidate the several geological reports.

The text is supplemented by tables showing in detail the locality, elevation, cost and characteristics of the artesian wells in each State. Other tables show the uses to which water from artesian wells is put, areas irrigated, effect and need of irrigation, land values and water rental and rainfall. A third series of tabulations presents data regarding natural springs, and a fourth relates to town water-works, deriving their supply from artesian or rend-flow waters.

Mr. HINTON'S individual report contains much valuable matter concerning the use of water from artesian wells for irrigating purposes in other countries, notably in Eastern India, other parts of Asia, Australia and on the Algerian Sahara.

The above is intended merely to present a general idea of the contents of the report. In a subsequent issue the details of the results of the investigations will be given.

—*Sewers, Ancient and Modern.* By C. WHEELER, JR., Mayor of Auburn, N. Y.—A paper read before the Cayuga County Historical Society in 1886, handsomely reprinted and illustrated. Gives a general historical sketch of drainage, chiefly devoted to London practice and a detailed history of the sewerage of Auburn, N. Y. One of its most valuable features is a series of very graphic illustrations of "how not to do it" in connection with household drainage. This part of the work, as well as much of the text, will teach little if anything to the engineer, but would be of especial interest to the unprofessional householder.

—*West Branch of the Susquehanna River.* Preliminary examination of, for the improvement of navigation and prevention of flood damage. By Major C. W. RAYMOND, Corps of Engineers, U. S. A. Report to Chief of Engineers, Dec. 20, 1890.

This examination covers a watershed of 6,900 sq. miles divided into six basins and lying from 430 ft. to 845 ft. above sea level. The slope of the main affluents range from 7 to 20 ft. per mile. The report deals with the recorded floods in the river, duration of storms and rainfall, and particularly the storm of May, 1889, which caused the Johnstown disaster. Major RAYMOND then takes up the causes which increase the destructive effects of floods, protection against floods, and the methods applicable to this river.

—*Geological Survey of Missouri*, Bulletin 2, on bibliography of the Geology of Missouri, by F. A. SAMSON. Bulletin 3, on the clay, lime and sand industries of St. Louis, by G. E. LADD, and the mineral waters of Henry, St. Clair, Johnson and Benton counties, by A. E. WOODWARD. Published by the Geological Survey, Jefferson City, Mo.

—*Report of the City Engineer, Haverhill, Mass.*, for 1890. J. T. DESMOND, City Engineer. Pamph., pp. 14.

A folding sheet in this report shows in plan and section improvements to Water St., consisting of concrete sidewalks, a retaining wall and a telford macadam pavement, with cobble paving for the gutters and between the street railway track.

—*Report of the Water Commissioners, Waterbury (Conn.)*, for the year 1890. WELTON & BONNETT, Engineers. Pamph., pp., 53.

This report contains reports and estimates regarding an additional supply of water from several sources, with analyses of water from each. There are also statistics of rainfall for the last four years; of receipts for 1890, by fixtures; and of the yearly collections of water rents since 1868.

—*Annual Report of the Ottawa Water-Works*, for 1890 ROBERT SURTEES, C. E., Engineer and Superintendent. Pamph., pp. 98 and index.

Aside from financial, pumping and other statistics this report contains a description of the renewal and extension of the clear water, or intake pipe; and of two 60-in. American turbines working under 25-ft. head and driving three single-acting pumps, each 26 × 60 ins. The pumps have a combined daily capacity of 10,000,000 galls., and were built by the Kingston (Ont.) Locomotive & Engine Co. from designs by JOHN KENNEDY, C. E., Montreal. A photographic reproduction show the pumps in place.

—*Report of the Fifth Annual Meeting of the Association of Executive Health Officers of Ontario*, held at Owen Sound, Aug. 19-21, 1890. P. H. BRYCE, M. D., Secretary. Toronto, Ont. Pamph., pp. 131.

The papers of engineering interest presented at the above named meeting were as follows: "Dangers from pit [dug or open] wells," by H. VAUX, M. D., Brockville; "The Owen Sound sewerage system," by A. CAMERON, M. D., Owen Sound; "Construction of public sewerage works on a revenue basis," by J. COVENTRY, M. D., Windsor; "What shall we do with sewage?" by T. MACFARLANE, Chief Analyst, Ottawa; "Sanitation in Brantford," by E. GRIFFIN, M. D., Brantford; "How deforesting has effected the public health," by C. MCKENNON, Trenton; "Results of a year's experience with the London Asylum Sewage Farm and the Precipitation Works at Agricultural College, Guelph," by C. G. HORETSKY, C. E., Public Works Department; "How soils dispose of organic matter; the process of nitrification," by P. H. BRYCE, M. D., Secretary Provincial Board of Health, Toronto.

—*U. S. Coast and Geodetic Survey.* Report of Superintendent F. M. THORN for the fiscal year ending with June, 1888. Washington: Government Printing Office. 1889. Quarto, pp. 566, illustrations and maps.

TRADE PUBLICATIONS.

—*Rosendale Cement, Its Uses and Mode of Application.* Compiled by LUDLOW V. CLARK, Jr. New York, 1891. Lawrence Cement Co., pamph. 22 pp.

Besides some practical hints on mixing and using concrete and mortar, this pamphlet contains the report, made in 1885, of the Committee of the American Society of Civil Engineers on a Uniform System of Tests for Cement.

SOCIETY PROCEEDINGS.

The Interstate Engineering Club has been organized in East St. Louis with the following officers: President, L. G. Mickles; Vice-President, C. A. Van Boercke; Secretary, C. L. Weber; Treasurer, F. C. H Aventz.

Engineers and Architects' Club of Louisville.—This new club has been organized at Louisville, Ky., with the following officers: Charles Hermany, President; C. J. Clarke, Vice-President; Granville W. Shaw, Secretary; John H. Thomas, Treasurer; Kenneth McDonald, Marshall Morris and John MacLeod, Directors.

Regular meetings on the second Wednesday in each month. Club room, 902 Commerce Building; open during business hours and at night.

Liverpool Engineering Society (England).—On Jan. 21 a party of members visited the central station of the Liverpool Electric Supply Co. At the meeting in the evening Mr. A. B. Holmes, M. Inst. C. E., engineer of the company, read a paper describing the works and plant. The company was formed in 1883, and has now three large central stations in working order. The total capacity is 15,500 lamps of 16 c. p., which can be extended to 37,000 lamps. The distributing mains are laid along a frontage of 9¼ miles, and the total length of single cable used is 41 miles. The Hookham electric meter is used.

The Civil Engineers' Society, of St. Paul, Minn.—Regular meeting of Feb. 2 held at the Hotel Ryan after entertaining the Minneapolis C. E. So. at dinner. Present, 18 members of the Minneapolis society and 15 members of the St. Paul society. President Mason read an address of welcome to our visitors. The President named Messrs. Rundlett, C. W. Johnson and Loweth as the Examining Board for the ensuing year. Mr. Van Duzee, of the Minneapolis society, then read a paper on sewer construction in Minneapolis. He illustrated the general plan of the system, recited its history and dwelt upon interesting details of construction. Minneapolis now has 80 miles of sewers, 20 of which were built the past year and wholly by day labor; 97% of the total mileage is the work of the last decade. Intercepting sewers dispose of a goodly volume of the storm waters, and all sewers are copiously flushed automatically. Mr. Münster's paper of last month on a short method to results obtained by Gordon's formula was then quite generally discussed. Immediately previous to adjournment announcement was made that the second of the four proposed joint meetings of the two societies would be held in Minneapolis probably on the first Thursday in March. C. L. ANNAN, Secretary.

Engineers' Club of Philadelphia.—Record of regular meeting, Jan. 17, 1891, President Wilfred Lewis in the chair; 19 members present. The Secretary presented, for Mr. Geo. R. Henderson, an illustated paper upon "Locomotive Driving Springs." He had occasion some years ago to examine quite thoroughly the laws governing the deflection of locomotive springs, and found the formula usually given in books to be incorrect, because the shape of the spring is not given due consideration. He constructed a new formula, which he has proved by actual tests in a number of cases.

Mr. Carl Hering read a paper on a "Portable Photometer for Measuring Street Lights and Illumination in General." After enumerating the difficulties attending such out-door measurements, he described the portable photometer devised by him, which had given very satisfactory results. The method adopted differed from the usual one in that the standard of light and the unknown light were both on the same side of the screen, and were balanced by an auxiliary portable light in the photometer at a fixed distance from the screen. The photometer is first calibrated by balancing this auxiliary light against the standard; this is done indoors. The photometer is then ready for use out of doors, the unknown light being balanced against the auxiliary by moving the whole photometer to or from the light. The adjustments are made so as to reduce the calculations to the simplest possible. The photometer consists of a light wooden tube open at both ends and containing the screen and auxiliary light, together with the switch and tape for measuring the distance. The auxiliary light was a small electric light supplied by a portable accumulator carried by the operator. This photometer could also be used to measure illumination in general, such as daylight, sunlight, moonlight, or the illumination on a table, desk, etc., for which measurements a stationary photometer cannot be used.

HOWARD MURPHY,
Secretary and Treasurer.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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D. McN. Stauffer, A. M. Wellington.....Editors
Chas. W. Baker, E. E. R. Tratman, M. N. Baker, F. P. Burt, } Associate Editors
Geo. H. Frost.....Business Manager

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Advertising rates. 20 cents per line *agate measure. Schedule sent on request.* **Changes** *of advertisements must be in hand on Tuesday afternoon;* **New** *advertisements Wednesday afternoon;* **Transient** *advertisements not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

COMING TECHNICAL MEETINGS.

New England Railroad Club.—Next meeting, March 11. Secy., F. M. Curtis.

Western Railway Club.—Next meeting, Feb. 17. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.

Engineers' Society of Western Pennsylvania.—Next meeting, Feb. 17. Secy., S. M. Wickersham, Pittsburg, Pa.

National Electric Light Association.—Annual meeting, Feb. 17-19, at Providence, R. I. Secy., A. R. Foote, Washington, D. C.

Boston Society of Civil Engineers.—Next meeting, Feb. 18. Secy., S. E. Tinkham.

Engineers' Club of St. Louis.—Next meeting, Feb. 18. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.

American Society of Civil Engineers.—Next meeting, Feb. 18. Secy., Francis Collingwood, 127 E. 23d St., New York.

Engineers' Club of Cincinnati.—Next meeting, Feb. 19. Secy., J. F. Wilson.

Northwest Railroad Club.—Next meeting, Feb. 19. Secy., H. P. Robinson, St. Paul, Minn.

New York Railroad Club.—Next meeting, Feb. 19. Rooms, Gilsey House. Secy., H. G. Prout.

Engineers' Club of Philadelphia.—Next meeting, Feb. 21. Secy., Howard Murphy, 1122 Girard St.

Denver Society of Civil Engineers.—Next meeting, Feb. 24. Secy., Geo. H. Angell.

Civil Engineers' Society of St. Paul.—Next meeting, March. 2. Secy., G. L. Wilson.

Western Society of Engineers.—Next meeting, March 3. Secy., J. W. Weston, 230 La Salle St., Chicago.

Technical Society of the Pacific Coast.—Next meeting March 6. Secy., O. von Geldern, 408 California St., San Francisco.

Civil Engineers' Club of Cleveland.—Next meeting, March 10. Secy., A. H. Porter, 50 Euclid Ave.

Civil Engineers' Association of Kansas.—Next meeting, March 11. Secy., J. C. Herring, Wichita, Kan.

Engineering Association of the Southwest.—Next meeting, March 12. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Northwestern Track and Bridge Association.—Next meeting, March 13. Secy., D. W. Meeker, St. Paul, Minn.

A GENERAL INDEX TO ENGINEERING NEWS, extending from the first issue of Volume I., in 1874, to the end of Volume XXIV. (July-December, 1890), is now in press, and will be issued about March 15, in a separate small volume, handsomely bound in cloth, which will be sold at $1. Orders for the index will now be received. It has been carefully compiled, and will contain references to every technical article of any importance which has appeared in this journal from its first issue up to date. The character of each article, whether illustrated, editorial, correspondence, news note, etc, will also be indicated. It will, therefore, prove a valuable work of reference even for those whose files are not complete.

WE rejoice to learn from the public press, and we trust correctly, that the financial embarrassments of the Westinghouse Electric Co. have been overcome, and with them the resulting annoyances to Mr. WESTINGHOUSE personally, and to the other great companies of which he is the head. VOLTAIRE, we believe it was, once remarked that "Men were seldom so usefully employed as when they were making money." If this be true even in the broad sense, as it unquestionably is, it is plainly still more true of those who, after having achieved one great success, prefer to take hold of other like enterprises and push them also to success, rather than to live the life of inglorious ease, which is their equitable privilege if they choose to avail themselves of it. This is true even of mere commercial or industrial enterprises, requiring merely business sagacity for their management, for a high degree of such sagacity is very rare. But it is still more true of such enterprises as require not merely nor chiefly business sagacity, but also a large measure of engineering insight and inventive skill to get them started and to keep them going; for the combination of these diverse qualities is naturally far rarer than either are separately.

IT is the peculiarity of every one of the "Westinghouse interests," so called, that they have been new departures in the field of engineering, as well as of business and manufacturing. The facts in regard to them are too well known for us to rehearse them in detail, but they cover a remarkable variety of new engineering enterprises, every one of which has been a technical success, and every one but the last a financial success as well, while the last also now bids fair to prove an exception no longer. The complete list of these enterprises, as given out by Mr. Westinghouse himself, is as follows:

Name of company.	Capital stock.	Dividends or net earnings.
1. Westinghouse Air Brake Co.	$5,000,000	25%
2. Union Switch and Signal Co.	1,500,000	8 to 12%
3. Westinghouse Machine Co.	500,000	20%
4. Philadelphia (nat. gas) Co	7,500,000	10%
5. Standard Underground Cable Co.	1,000,000	25%
6. Allegheny Co. Light Co.	1,000,000	8%
7. Fuel, Gas and Mfg. Co.	1,000,000	12%
8. Westinghouse Electric & Mfg. Co	10,000,000	.....
Total	$27,500,000	

There are various other companies of the same general nature, like the Consolidated Car Heating Co., of Albany, N. Y., in which Mr. WESTINGHOUSE has important interests, though of less moment than in the distinctively Westinghouse companies. The particular causes which led to the embarrassments of the company, last named above, we will not undertake to summarize, nor are we well enough informed to do so, but one general cause plainly was that Mr. WESTINGHOUSE has always had the courage of his convictions, and has not stinted expense in putting his enterprises on a basis for doing a large business from the beginning. It would have been a public misfortune had this liberal policy resulted in permanent embarrassment. We rejoice to learn that it has not.

THE *Evening Post*, of this city, calls attention to an important feature of the new rapid transit bill, which had escaped our attention, in the following words:

> It would not be surprising if the elevated railways were to go before the Rapid Transit Commission with a request for permission to build a second story upon their present foundations. As the thirty-second section of the rapid transit bill was first drawn it authorized any existing railway company to "lay an additional track or tracks on a portion or the whole of its railway." As amended and as enacted into law this passage reads: "lay an additional track or tracks *above, under or contiguous to a portion or the whole of the route or routes of its railway.*" According to that phraseology the elevated roads can build an entire new structure above their present one, or under it or adjoining it, provided they can obtain consent from the Commission and from the local authorities. It was said some time ago that a scheme for a double-decked structure upon the present foundations had been devised, and cuts of it were published in a newspaper very friendly to JAY GOULD. It looks as if somebody very friendly to the idea had taken a hand in amending this thirty-second section of the law.

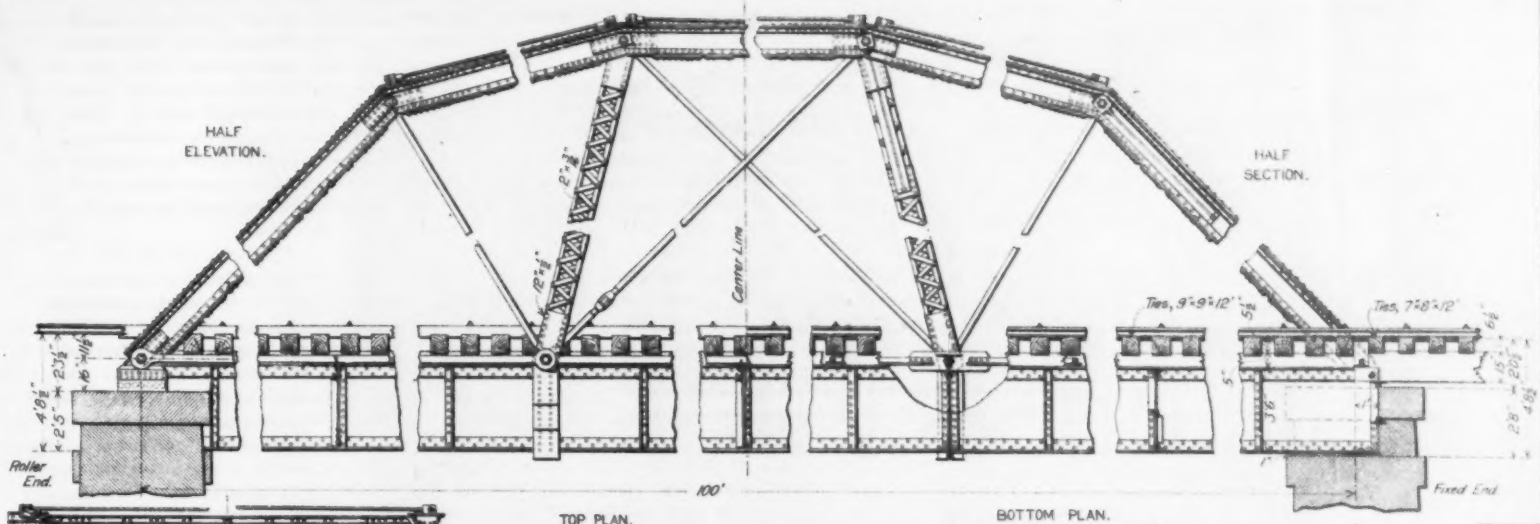
It certainly does look as if the bill had been framed with a direct view to enabling the existing elevated railways to duplicate their present roadbeds by an overhead structure. If they should likewise get permission to add the third track, on which much work has been already done, they might soon find themselves provided with six tracks instead of two on their most crowded lines. It was tolerably apparent that both the Manhattan and the New York Central companies were well enough satisfied with the bill as passed, since there was practically no opposition to it.

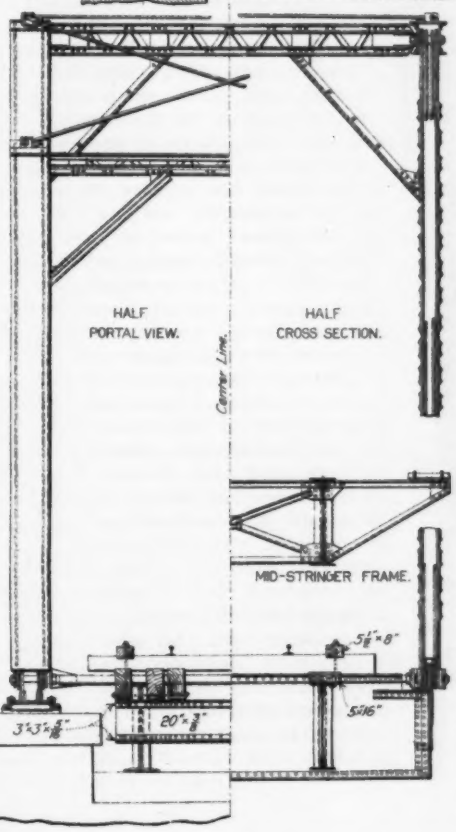
Nor are we prepared to say that, from the standpoint of the public interest, the suggested addition of a second deck to the existing elevated structures might not be a wise measure. There should be an end to the giving away of these profitable franchises without due compensation or without strict stipulations for the protection of the public comfort, but such a second deck would give a large addition to capacity without defacing any new streets or sensibly injuring private property more than it has been already injured (where it has in fact been injured). It would not be an adequate substitute for needed improvements like the extension of the Harlem Railroad tracks down to the City Hall, but it would furnish a possible mode for a large and speedy addition to much overtaxed existing facilities.

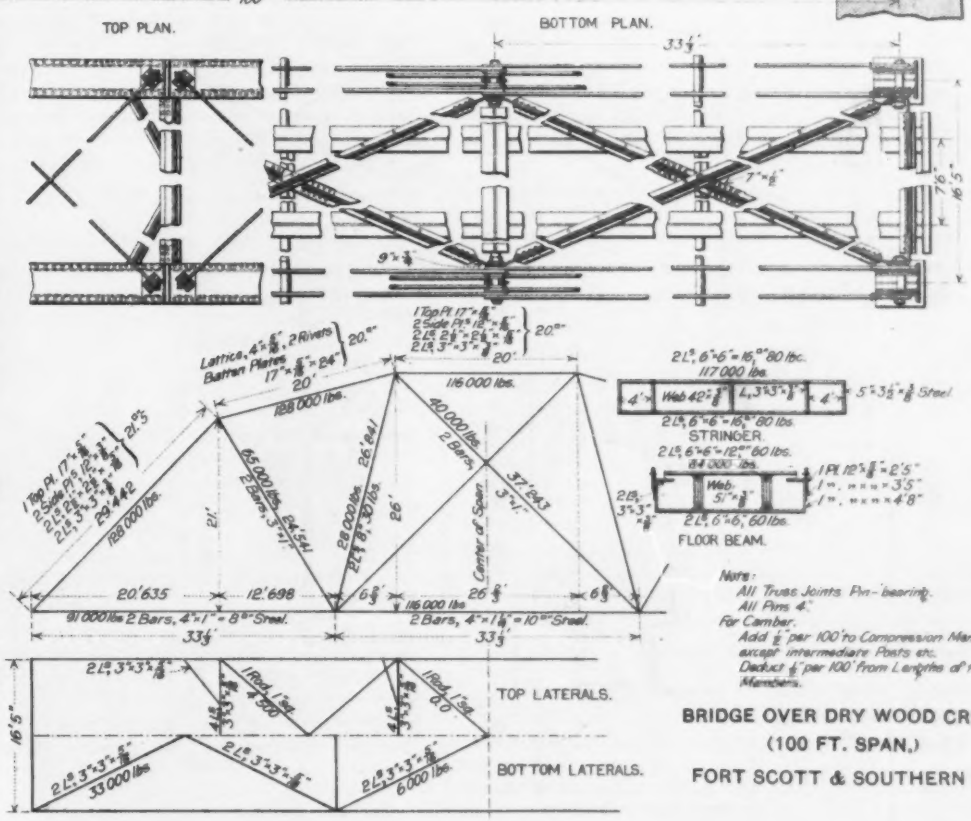
ALLUSION was made in our issue of Jan. 24 to the defect in the design of locomotive roundhouses, as generally constructed, in that any blocking of the single exit over the turntable stops all passage of locomotives out of the building. This we illustrated by the recent fire at Montclair, N. J., where the blocking of the tracks at the turntable in an emergency resulted in the burning of half a dozen coaches and as many freight cars. Another illustration of the danger which exists in this common type of locomotive shed occurred at Portland, Ore., in the latter part of last month, and has been called to our attention by a correspondent. The following account of the manner in which the locomotives were locked in the burning engine house we extract from the *Oregonian*:

> Five locomotives and a mail car were in the house at the time, and the efforts of the railway hands, the first men on the scene, were directed toward removing this valuable property to a place of safety. Engine No. 12, on which steam was up, was quickly run out on a sidetrack, and No. 18, with its cab and the wood supply of the tender briskly burning, was next pushed out on the turntable. In some way the fore wheels of the engine left the track before she had passed off the table, effectually preventing any further attempt at removing the remaining engines from the burning buildings. These were Nos. 20, 42 and 17, and in a very short time they were entirely surrounded by a burning, roaring mass. The mail car was completely destroyed.

The building in this case seems to have been an excellent fire trap, as a carpenter shop filled with inflammable stuff was in one part of the building.

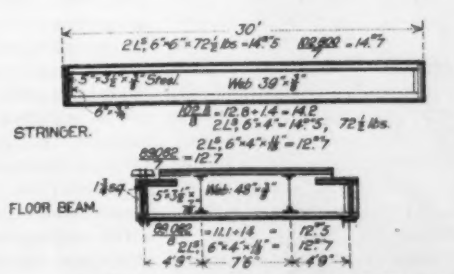




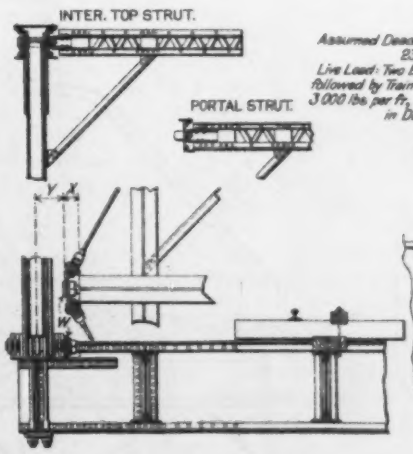


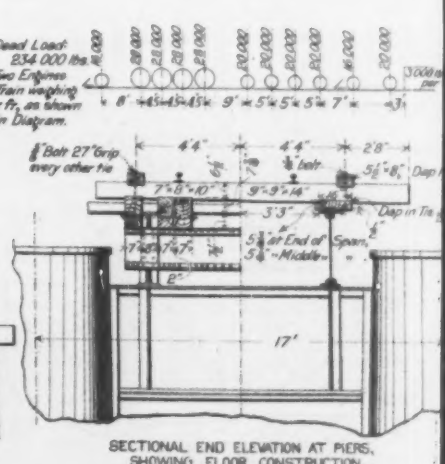
Notes:
All Truss Joints Pin-bearing.
All Pins 4".
For Camber,
Add ⅛" per 100' to Compression Members, except intermediate Posts etc.
Deduct ⅛" per 100' from Lengths of tensile Members.

BRIDGE OVER DRY WOOD CREEK
(100 FT. SPAN.)
FORT SCOTT & SOUTHERN RY.



Span 150' in 5 Panels of 30'. Depth at Middle 28'740, at End 22'000. Top Chord Panel Points lie in a circular Arc with Radius = 219'571, Chord = 110' and Versed Sine = 7" Middle Top Chord Panel made ⅛ less between Pin Centers to make Chord Sections of equal Lengths and same Bevel.
For Camber: Lengthen Top Chords ⅛ Length and Posts, (2000 − 1/10) Shorten Bottom Chords and Main Ties 2000 − 1/20 Lengths in Figure are without Camber.
Note. Difference in Lengths of Intermediate Posts (⅛+) to be made in boring Pin Holes. Except this end Sections, Posts to be exactly alike. Distances X and Y to be made constant by Washer W to make Floor Beams and Bottom Laterals alike throughout.



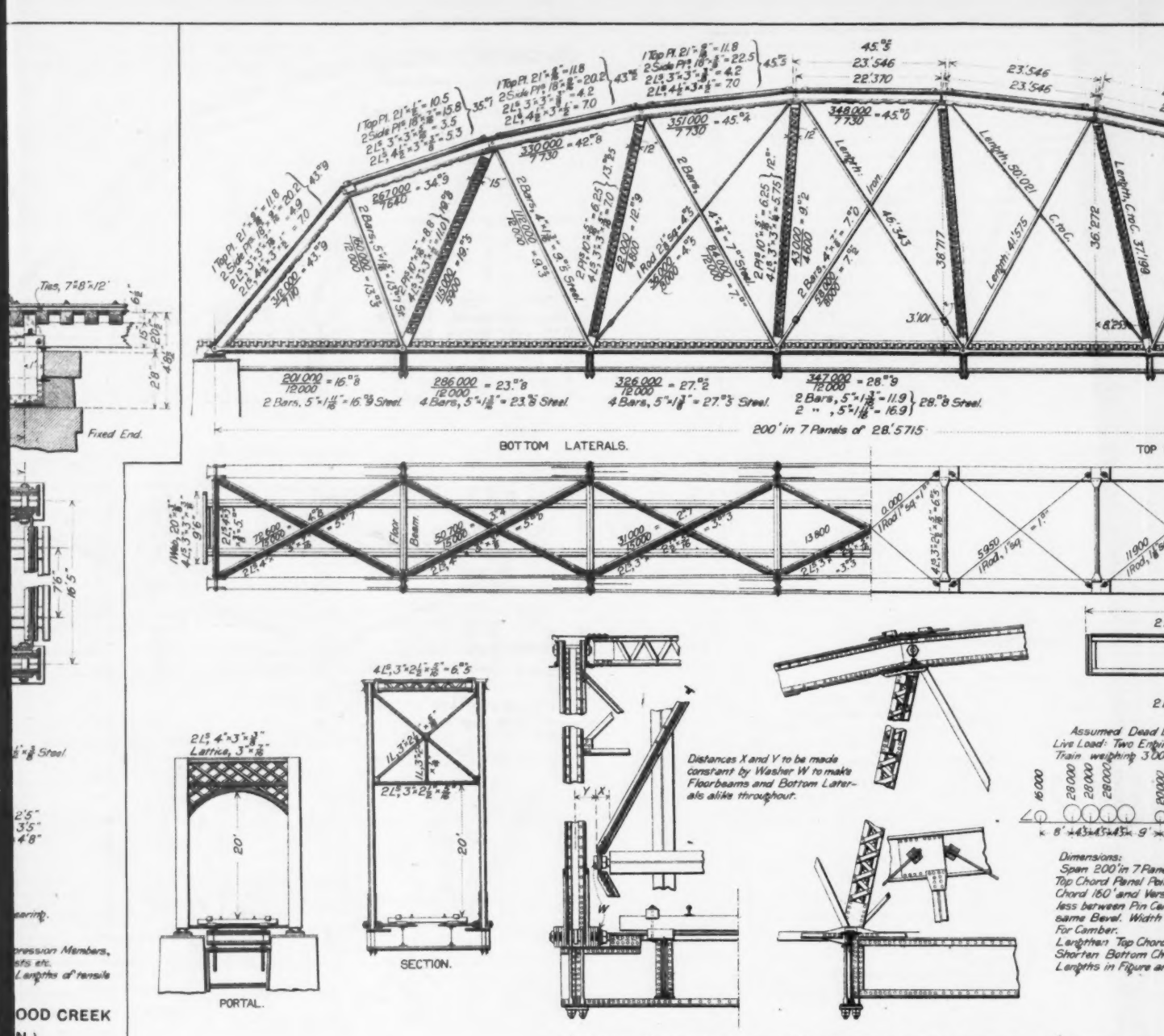

Assumed Dead Load 234 000 lbs.
Live Load: Two Engines followed by Train weighing 3 000 lbs. per ft. as shown in Diagram.
⅞" Batr 27" Grip every other tie
17'
Dap in Tie
Span.

SECTIONAL END ELEVATION AT PIERS, SHOWING FLOOR CONSTRUCTION.

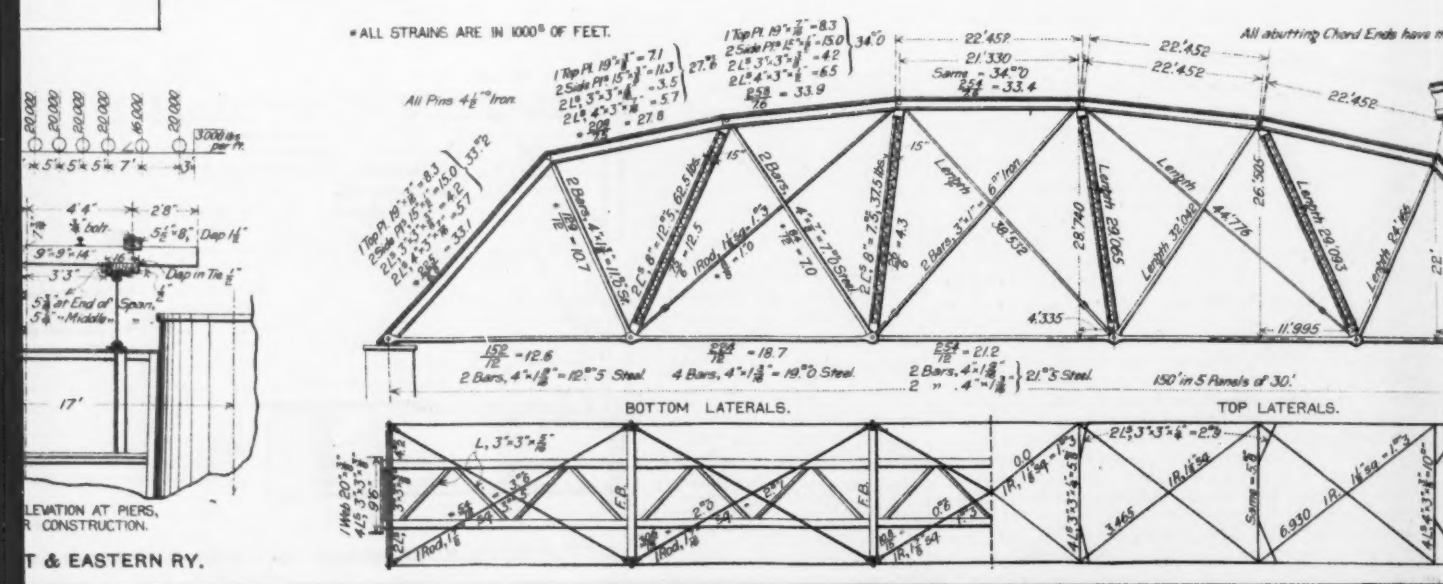
LITTLE OSAGE RIVER BRIDGE (150 FT. SPAN.) FORT SCOTT & EASTERN RY.

GEO. H. PEGRAM, CONSULTING ENGINEER.

MISSOURI PACI



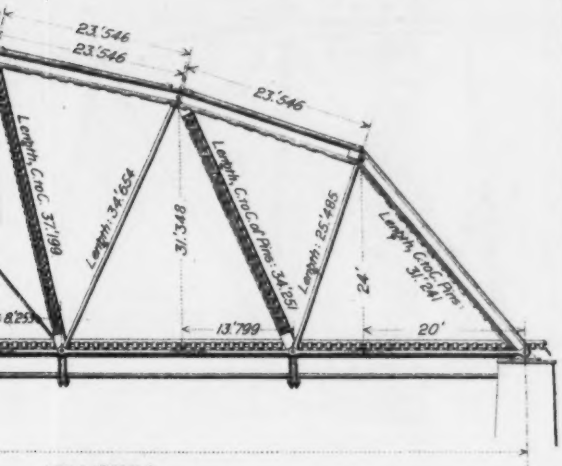
MARMATON RIVER BRIDGE (200 FT. SPAN.) FORT SCOTT & EASTERN RY.



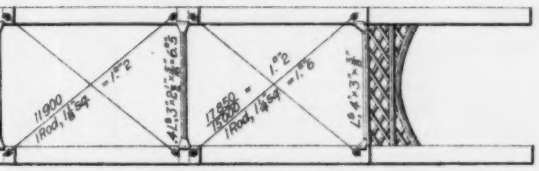
T & EASTERN RY.

MISSOURI PACIFIC RAILWAY BRIDGES.

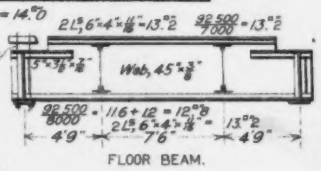
JAMES W. WAY, CHIEF ENGINEER.



TOP LATERALS.



STRINGER.



FLOOR BEAM.

med Dead Load: 350 000 lbs.
d: Two Engines Followed by a
eighing 3 000 lbs per foot.

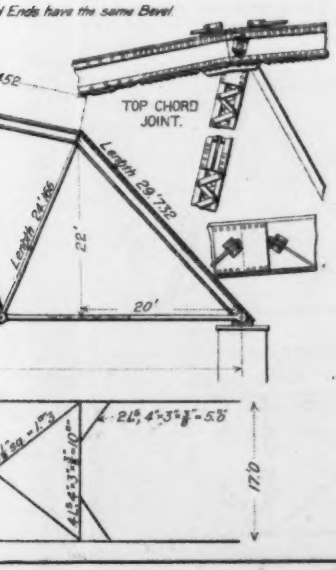
20000 20000 20000 20000 16000 20000

9' 5' 5' 5' 7' 3'

ions:
200 in 7 Panels of 28'5715. Depth at Middle 38'717, at End 24'.
rd Panel Points lie in a circular Arc with Radius = 220'833,
60' and Versed Sine = 15'. Middle Top Chord Panel made 1/10
ween Pin Centers to make Chord Sections of equal Lengths and
Bevel. Width 17'.
ber.
en Top Chords 1/2000 of Length and Posts (1/2000 + 1/32").
Bottom Chords and Main Ties (1/2500 + 1/32").
s in Figure are without Camber.

RN RY.

Ends have the same Bevel.



CHAS. HART & SONS, LITH., 88 VESEY ST., N.Y.

In mc[s] engine houses, however, the fire risk is consic[i]ble, and it is to be remembered that a loss may result, even when the engine house itself is reasonably fire-proof, through the blocking of the exit from the house. At the Montclair fire, for instance, the engines were wanted to move the cars away from the burning freight depot. Cases have occurred, too, in which a serious stoppage of traffic has resulted from the blocking of the track at the turntable.

AN interesting question is raised in an editorial from the Philadelphia *Manufacturer*, elsewhere published in this issue, regarding the advisability of a change in the method of raising the money required for street construction and maintenance. The usual custom is to divide this tax between the owners of property abutting on the street and city itself, in proportions varying with locality and the immediate purpose in view. As a substitute for this a small tax on horses and vehicles of all kinds is proposed, with the proceeds of this particular tax solely devoted to the construction and maintenance of thoroughly good street pavement. Theoretically, this scheme seems better than the one in use; but practically we can see a number of difficulties in the way of its adoption. The first problem would be the securing of an accurate census of owners of vehicles and horses, and a second would be the adjustment of the tax to the use the owner makes of the street. The third and greatest difficulty, however, would lie in the disposal of this tax in such manner as to really benefit the class directly taxed. There is no doubt that there is a decided economy in a good and well maintained road surface to every owner of vehicles and beasts of burden, in reduced tractive power and diminished wear and tear. But there is also a gain to every property owner, in better drainage, improved sanitary conditions and the decrease of noise, dust, etc. The question is where to draw the line between the two classes for purposes of taxation. The truth of the matter is that the streets of a city belong to the citizens generally, every one of whom is benefited in some varying degree by their excellence, and suffers in like proportion from their bad condition. There is doubtless room for a more equitable distribution of the cost of providing, what none of our cities yet have, thoroughly good street pavements; but the bulk of the money for accomplishing this end should come from a general tax rather than a class taxation. We shall have something further to say upon this subject later.

THE plans for celebrating the centennial anniversary of the establishment of the American patent system are rapidly being matured. The programme as now published includes meetings on April 7 to 10, inclusive. The presiding officer on the first day is to be President HARRISON and on the following days Secretary NOBLE, Hon. FREDERICK FRALEY, Prof. S. P. LANGLEY, Secretary of the Smithsonian Institute, and Prof. A. GRAHAM BELL, of telephone fame. A reception is to be given at the Patent Office on the evening of April 8 by Secretary NOBLE and Commissioner MITCHELL. Among the prominent speakers at the public meetings are to be EDWARD ATKINSON, Justice BLATCHFORD, of the Supreme Court; OCTAVE CHANUTE, Pres. Am. Soc. C. E.; Commissioner MITCHELL, of the Patent Office; Congressman BUTTERWORTH, who was formerly at the head of the Patent Office; Congressional Librarian A. R. SPOFFORD, and Professors R. H. THURSTON, W. P. TROWBRIDGE, CYRUS F. BRACKETT, F. W. CLARKE and THOMAS GRAY. A detailed programme may be obtained from the Secretary, J. E. WATKINS, 811 G St. N. W., Washington, D. C.

What may be the most important outcome of the celebration is the formation of a National Association of Inventors and Manufacturers. A meeting for the formation of such an association is set down for the afternoon of April 7. Whether an influential society can really be organized under this broad title, remains to be seen; but there is no doubt that if it were organized and would then take up in earnest the work of reforming the American patent system and bringing it up with the times, the society should receive universal support. In fact there seems to be really no other object for the formation of such an association, for this is, in fact, the one thing in which all inventors and all manufacturers, no matter what their occupation, have a common interest.

That the patent system needs some radical changes to make it applicable to the conditions of modern science and art, few will deny. A fund of over $5,000,000 now stands to the credit of the Patent Office in the Treasury, being the total surplus which has thus far resulted from the operations of the Patent Office. This fund should be used to extend the facilities of the office, and the annual surplus, which amounted to $266,029 for the last fiscal year, should be spent to increase and raise the standard of the working staff. Other and more radical changes are certainly needed, but they should be made with great caution. An investigation of the subject by an expert commission might well be made.

THE American navy has now some of the best war ships afloat, would have said Secretary TRACY at the Delmonico dinner had not the sudden death of Secretary WINDOM brought the programme to an unexpected close. From notes for this speech we are reminded that in 1865 we had a navy of 700 vessels of all classes, manned by 50,000 men, the largest and most powerful fleet the world had ever seen. But in 24 years we fell from the first to the thirteenth naval power, with little Holland possessing 94 warships against the 42 of the United States. In 1882 we commenced building a new navy. In speaking of the new ships the notes say that on Oct. 1, 1890, contracts were awarded for three ships to cost $3,750,000 in the aggregate, and "it is not believed that their equal as fighting ships exists to-day." These ships, with a displacement of 10,200 tons, have a length of 348 ft. and a beam of 69 ft. 3 in., a sea speed of 15 knots and a maximum speed of 16.2 knots. The side armor is 18 ins., and that on the turrets and barbettes is 17 ins. The battery is the heaviest yet proposed, and will consist of four 13-in., eight 8-in., four 6-in., sixteen six-pounders, four one-pounders and four Gatling guns. The weight of these guns, with their carriages, is 671 tons, and they will discharge at one broadside 6,500 lbs. of metal, or nearly 3 tons. Secretary TRACY graphically explains what the 33,000 foot-tons of energy, developed by one 13-in. projectile, means by showing that such a shot would penetrate 26 ins. of solid steel, or lift the 10,000-ton ship described 3 ft. into the air. And the total energy of all the guns of this battle ship would lift her 21 ft. out of the water. "No battery afloat or designed abroad has equal power or efficiency." This is the new battle-ship built to fight and not to run away.

Cruiser No. 12 is then referred to by the Secretary as a commerce destroyer, and especially designed to run. Here coal endurance is an essential, and this ship is of a distinctive type, having no parallel in the navies of the world. Her first characteristic is great speed, and the contract calls for a sustained sea rate of 21 knots per hour, and 22 knots is expected. With 7,400 tons displacement this cruiser has a length of 412 ft., making her the longest war ship in the world, and a beam of 58 ft. The three triple-expansion engines will drive three screws, and develop over 20,000 HP. She has a coal capacity of 2,000 tons, and could steam at 10 knots per hour for 108 days, or around the world without recoaling. While Cruiser No. 12 has a battery sufficiently powerful to sink any Atlantic liner that would be armed for self-protection, and has 4-in. deck armor, she is not built for fighting war ships, and would keep away from them.

While our ships are few in number as yet, it is gratifying to hear that they outrank in class and in both fighting and running qualities the famed modern navies of the world. We badly needed some salve of this kind to heal the wounds of late years inflicted upon our national pride, and to help us to forget the mortification of these years whenever our antiquated "wooden walls" came into contrast with the model monsters of other nations. But we have gained wisdom by their experience, experiments and blunders, and it would be the reverse of complimentary to our engineers and naval architects if we did not improve upon past methods and even present practice in other nations.

The Bottom Facts of the Brooklyn Bridge Question.

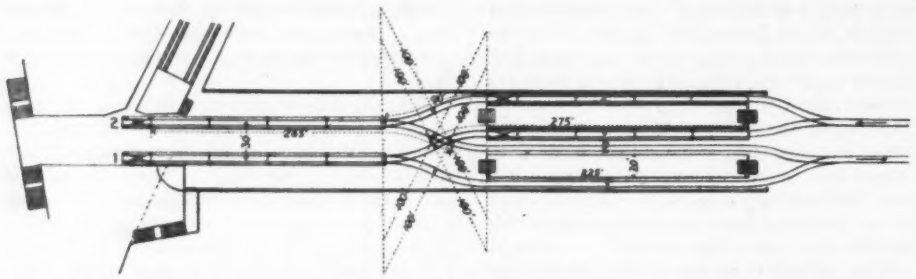
OUR readers will remember, or will find by turning back to our issue of Jan. 24, that we published an article on "The Second Expert Report on the Brooklyn Bridge," in which we made the following statement:

> In the italicized sentences [quotations from the Board of Experts' report stating the capacity to be had under their recommendations] the second Board of Experts has recommended, not simply questionable or hazardous procedures, but physical impossibilities; impossibilities as certain, if not so transparently evident, as if they had recommended with equal gravity that three pints be carried in a quart pot.
>
> This fact, and no other, we propose to point out and record at this time, not with either hope or expectation that it will influence the appeal of the Board of Trustees to the tribunal of Experience, but partly as a matter of duty to the public, whose lives and comfort are at stake, and partly to lay the necessary foundation for enjoying hereafter the gentle satisfaction of saying "I told you so," which is the natural right and privilege of every person who has the foresight to lay a proper foundation for it.

We then pointed out specifically one of a number of reasons which make it certain that the second Board of Experts has in fact done just what we stated in recommending the plan which the trustees adopted three years ago, and which has stood as "adopted" ever since, though not the first step was ever taken to put it into execution; perhaps because of a like caution to that above quoted which appeared in ENGINEERING NEWS of April 28, 1888.

In neither of this cases, however, have we done more than to simply announce that the capacity claimed was a physical impossibility. We have not attempted to demonstrate that fact affirmatively. A communication signed "Dot," which claims to be inspired, and to set forth the precise method "which the Board proposes to employ" to accomplish what we have declared to be a physical impossibility, was published last week, however, which puts a different face on the matter. We reprint this communication in full in another column. While the claim itself was vague, the denial of possibility must properly be vague also. When the claim becomes specific, we recognize that there is a certain claim upon us to make the demonstration of impossibility specific likewise.

We accept the task with pleasure; and while we are about it we will demonstrate, further, that another official or semi-official attempt to explain how the alleged miracle could be accomplished is likewise fatally defective. About a year ago Mr. G. LEVERICH, Assistant Engineer on the bridge staff, put forth a pamphlet entitled "The Traffic Capacity of the New York and Brooklyn Bridge," in which he purported to show by a series of diagrams how trains could be handled under the so-called Barnes-Martin plan of double tail-switches (see the cut on next page) with almost any headway, from 40 seconds up.



PLAN OF THE PLATFORM AND SWITCHING ARRANGEMENTS FOR THE NEW YORK TERMINAL OF THE BROOKLYN BRIDGE AS RECOMMENDED BY THE SECOND BOARD OF EXPERTS.

[This is a reduced copy to scale of the specified features of the ground plan which accompanies the Board of Experts' report. It should be referred to rather than the sketch or diagram which accompanies the communication signed "Dot" (which is not to scale), to understand the actual situation. We have added to this plan (1) the radii of the reversed 100 ft. radius curves in which the crossing occurs, and (2) a four car train with engine attached to it in position on the stubs and at the platforms. The cars are shown 50 ft. long, and the engine 25 ft. long. The existing elevated railway station is shown in place. The western limit of the stubs is fixed by law: they are barely long enough to hold the train with the rear platform projecting over the switch. The station is recommended to be a story higher than the present station, having a large waiting room below it.]

These two are the only attempts which have as yet been made to show a way to accomplish the alleged impossibility. They deal with precisely the same plan, and emanate from substantially the same source, yet it is curious to note that they propose radically different methods of handling the trains, each of them alike impossible, but impossible for quite different reasons. We proceed to dispose of them in chronological order. We shall not need to be long about it, nor very abstruse.

Mr. LEVERICH'S diagrams for 40 and 45 seconds headway are reproduced photographically below, slightly reduced. The plan to which they (and we) refer is shown at the side of them, but more clearly and fully in the accompanying large scale diagram, which we may briefly describe.

The trains of four cars come to the incoming platforms *A* and *B* alternately, and when a switch

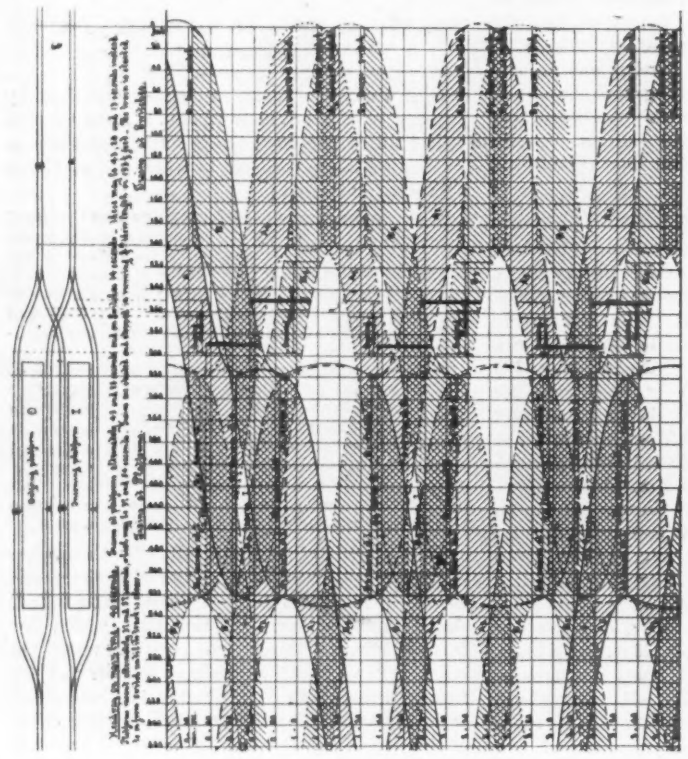


Diagram for 40 Seconds Headway.

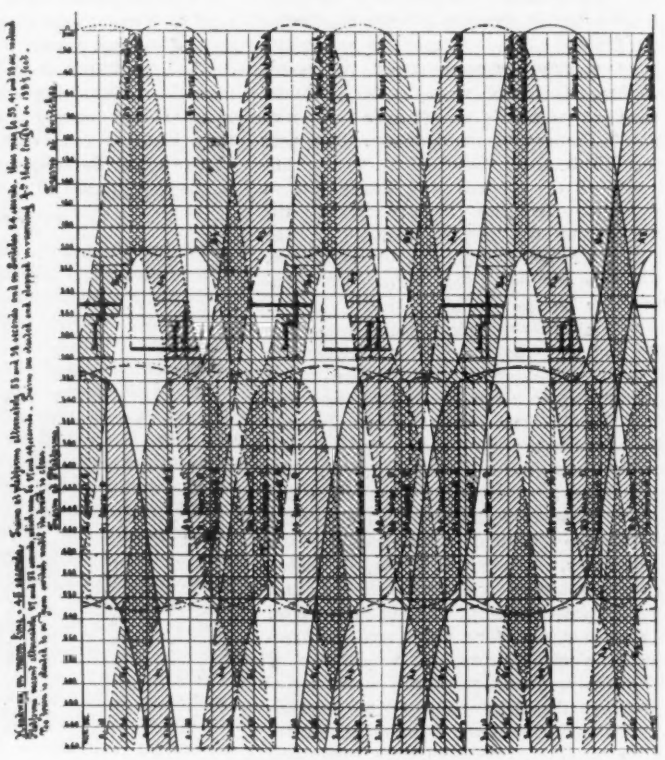


Diagram for 45 Seconds Headway.

DIAGRAMS PUBLISHED BY G. LEVERICH, ASSISTANT ENGINEER N. Y. & B. BRIDGE, ALLEGED TO SHOW HOW 4-CAR TRAINS CAN BE HANDLED INTO AND OUT OF A STATION ARRANGED AS PER SKETCH AT SIDE.

Incoming platform marked I; outgoing platform, O.

[The diagrams are exact reproductions of the original, except that dark horizontal lines are added to indicate the period of time during which each successive train is occupying the crossing or the 50 ft. of track approaching it.]

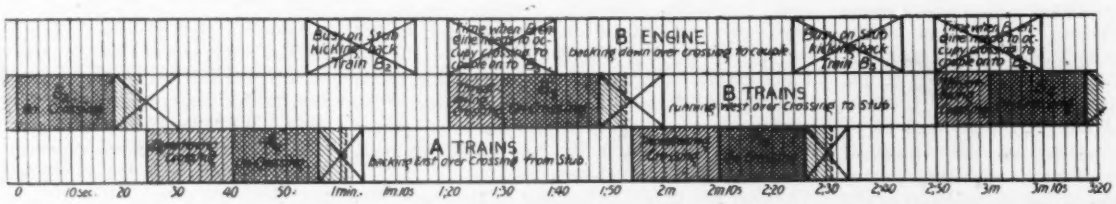


Diagram showing separately the crucial features of the train movements called for by the Leverich diagram for 45 seconds headway, and showing the elements of impossibility therein. (See note below).

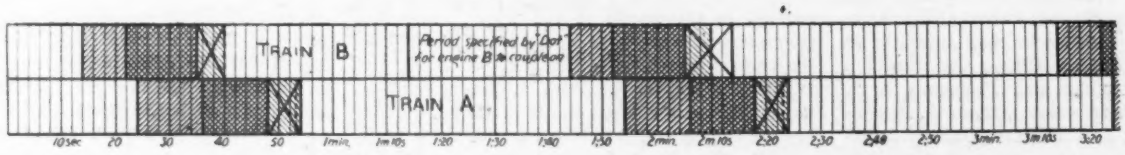


Diagram showing the crucial features of the train movements called for by the schedule announced by "Dot," and the elements of impossibility therein.

DIAGRAMS SHOWING THE ELEMENTS OF IMPOSSIBILITY IN THE PLAN FOR ENLARGING THE CAPACITY OF THE BROOKLYN BRIDGE RECOMMENDED BY THE SECOND BOARD OF EXPERTS.

[In each of these diagrams nothing is shown except the movements of the trains on the trips which obstruct the crossing; viz., the run of the A train (or the No. 2 tracks in the plan above) backing down from the stub, and the run of the B trains (or the No. 1 tracks) running out to the stub. This is shown as explained on cut and in the text.]

engine has coupled on at their head precisely fill it. When run out on the switch they precisely fill that also; in fact, a little more than fill it, there being just room for the rear trucks to clear the switch when the engine is at the head block. Between the train on the switch and the train at the platforms there is an interval of some 90 ft., near the middle of which occurs the crossing. Over this crossing, it will be seen, every *A* train (on the No. 2 tracks) passes in backing down *from* the stub, and every *B* train (on the No. 1 tracks) passes in pulling out *to* the stub.

The trains are merely "kicked" back from the stubs to the outgoing platform, the engine running about half way only. Wipe out either the *A* tracks or the *B* tracks, and we have the present single system of tail switching, except for one fact; two engines are employed in practice in order to hasten by a few seconds the process of coupling on, each engine having a stub track of its own. This will be no longer possible under the double system.

Mr. LEVERICH'S diagrams purport to show just how trains are to be handled over these tracks on headways of either 40 or 45 seconds. The trains are supposed to preserve uniform headways on the open road, but stand at platforms for varying intervals, as noted, for the apparent purpose of making a *B* train, pulling out *to* the stub, follow an *A* train backing down *from* stub very quickly, in order to leave a gap of some 20 or more seconds in each 90; during which the crossing is not occupied by trains, and so can be used by the *B* switch engine to back down over the crossing to couple on to the next succeeding *B* or No. 2 train.

So it could do in safety, perhaps, once out of every three or four trials, but for one fatal omission: In the few brief seconds which are alone available for this operation the *B* engine is otherwise engaged, a couple of hundred feet off, "kicking" down the preceding *B* train to the outgoing platform. By the time this operation is over it is too late for it to use the crossing to any purpose, for the instant at which it ends its "kicking" duties *is the instant at which it ought to be already pulling out with the next succeeding B train in order to get it out of the way in time for the passage of the next succeeding A train.* This sentence is a little complex to follow mentally, we admit, but it will become clearer by examining the accompanying diagrams.

All that has been stated (and some other things yet to be stated) is easily enough seen from Mr. LEVERICH'S own diagrams, if the reader knows how to study them carefully, and cares enough to do so; but we must be excused for suggesting that the original diagrams are much better calculated to confuse and mislead the inexpert than to enlighten them, since they are obscured by so much irrelevant detail. To make them a little clearer we have drawn on some heavy black lines, each of which indicates by its length the period of time during which the respective trains are occupying the crossing. Where this line runs across a shaded area (belonging to its own train), the train is actually on the crossing; where it is on an unshaded area the train is occupying the crossing by being in motion toward it from a point 45 ft. or less away. It is needless to say that this is as much "occupying" the crossing as if the train was actually on it. In other words, no rational man will schedule an engine to begin moving toward a crossing from a point less than 50 ft. away until a train which is passing over it had actually cleared it. This fact, we are pleased to see, is recognized in the 45-second diagram at least, for some 4 seconds are allowed for reflection after one train has cleared the crossing before the next train starts toward it. But in the 40-second diagram not even this slight concession to reason is made. One train starts toward the crossing before another has cleared it, because the black lines overlap.

To make the "business end" of this diagram entirely clear, however, we have extracted its substance in the much simpler diagram shown below it, in which three parallel strips are devoted to the respective movements of the *A* train, *B* train and *B* engine, and nothing is shown as to either of them except the respective periods during which they occupy or need to occupy the crossing. As explained below the diagram, the different parts of the train movement are shown in three ways:

1. The period of actual operation of the crossing is shown by a double-hatched area.

2. The preceding period when the train occupies the crossing by being in motion toward it within 45 ft. is indicated by dark single hatching.

3. A succeeding period of 5 *seconds* only for possible "variation of watches" and irregularity of movement is indicated by light single hatching.

4. The entire period between the clearance of the crossing and coming to rest on the stub (which includes the 5 seconds allowance) is indicated by a large cross.

All this is shown on our diagram precisely as Mr. LEVERICH shows it in his diagrams, only in a way to make it clear; and our diagram shows at once to the eye, as clearly as it is possible to show anything of that nature, that do what one will with these trains, short of actually bunting them into each other on the crossing, and granting them all to run on time with absolute precision, it is an utter impossibility to run switch engine *B* past the gantlet at any time when it is not otherwise occupied in another locality.

This, therefore, is Impossibility No. 1; but there is another Impossibility No. 2 in this schedule. There is something that looks like a gap where, if we could only have one engine in two places at once, it looks as if there might be a chance to squeeze it through. We may have an engine in two places at once by using two engines for the *B* tracks, at least, and probably for the *A* tracks also. Can the proposed schedule be made possible in this way, say by turning off a switch from *the inside* of a 100-ft. radius curve, which seems the only way available?

By no means. In the first place, such switches are impossible. In the second place, they are not shown upon the plan, and would have damned it at once if they had been, though there are not wanting signs which we shall reach later that this may have been the real intention from the first. In the third place, no relief would be obtained from them, and the Leverich schedule or any reasonable approach to it would still remain utterly impossible, for this reason:

We have heretofore assumed (or rather granted) absolute regularity in the movements of trains. We need hardly say that this is an entirely improper and absurd assumption. No trains can be run with absolute regularity, even by a cable, still less by switching engines, or when loading and unloading; and Mr. LEVERICH himself has furnished us with a measure of the actual irregularity which is found necessary in practice in the very pamphlet from which we have extracted his diagrams. He records observations made on 20 successive trains running on the minimum headway of 90 seconds during the rush hour. The period of observation thus covered is only half an hour, and we may be quite sure was so selected as to make at least a fair average showing. In next column is the showing, rearranged from his table. Here we see that there was very great irregularity of movement even in a single half hour, ranging from 30 to 107 per cent. in the time required for the several movements. We have this week made some further observations of like nature which we shall publish next week, showing some improvement on the LEVERICH record, but essentially similar to them. They were not completed in time for this issue.

In Mr. LEVERICH'S record the process of pulling trains back to stub, for which he allows only 40 seconds, actually averages 48.8 seconds, ranging

ACTUAL RESULTS OF EXPERIENCE IN HANDLING BROOKLYN BRIDGE FOUR-CAR TRAINS.

[Abstracted from table on p. 27 of pamphlet on "Traffic Capacity of Brooklyn Bridge," by Mr. G. LEVERICH, Assistant Engineer. Record taken on Friday, Oct. 25, 1889, and covering 20 4-car trains, running on 90 seconds headway.]

	Average.	Minimum.	Maximum.	Range.	
	Secs.	Secs.	Secs.	Secs.	Per cent.
Starting at incoming platform	31.5	20	43	23	73
Pulling back to rear stub	48.8	45	63	18	37
Standing still on stub	22.4	15	39	24	107
Kicking out to outgoing platform	32.9	27	37	10	30
Standing at outgoing platform	40.7	31	50	19	47
Total time at station	176.1	161	194	33	18.8

all the way from 45 to 63 seconds, and it will be seen that it is the maximum and not the average period which must be allowed for to make a working schedule. Make this change in the hatched portion of our diagram, and see what effect it has! Regularity so great as to dispense with 10 or 15 seconds leeway in each direction for each movement is not attainable, even with a single switching system, with no crossing to look out for and no collisions to fear. How, then, can it be expected for an interlacing double system?

Here, therefore, is Impossibility No. 2. At what precise headway it ceases to exist, and so makes the operation of the now famous BARNES-MARTIN plan a practical possibility, we do not propose to take the trouble to demonstrate now or at any other time. But it is capable of sufficiently vigorous demonstration if one goes about it rightly, and we will tell the Bridge authorities precisely where it is, for their instruction, their second Board of Experts to the contrary, notwithstanding. It lies a little on the wrong side of 60-second headways. In other words, the real gain in possible car-dispatching capacity, instead of being 100 per cent. as a minimum, as the Board of Experts have certified, is between 45 and 50 per cent. as a maximum. They can never, even for a single turn, dispatch more cars than this without an accident, even if they ever attempt to carry out the plans. If they lay some tracks down somewhere and try it they will soon find this out.

Having disposed of the Leverich schedule we have disposed of the only one which is worth serious attention. The "Dot" schedule, which is declared to be that proposed by the Board of Experts, is too absurd for serious attention, and we trust that he slanders the Board in ascribing it to them. The man or men who made it had waded in away beyond their depth. We simply plot it in two parallel lines; any one can check the plot from our reprint of his letter. It will be seen at once the schedule proposes such a movement that they must inevitably come into collision every 90 seconds unless by some happy accident; and in every case the *A* train starts to *back* toward the crossing before the *B* train has fairly entered upon it. The *A* train has still nearly 3½ cars to get over the crossing when the *B* train starts to *back* toward it with only 40 ft. or thereabouts of clear track between it and the crossing! Here, therefore, we have Impossibility No. 3.

It would seem unnecessary to further discuss the ideas and opinions of any one capable of such a bull as this, in so important a matter. No rational person is likely to take much interest in them, but, nevertheless, we may as well make a clean job of it. It will be seen from the notes under the "Dot" diagram that Impossibility No. 3 might be corrected by changing the intervals between the *A* and *B* trains from 20 and 70 seconds to 30 and 60 seconds. It is not really possible to do this for the the period of 30 seconds which is allowed, for the movements of the *B* switch engine is the least

which is possible, even on paper, for driving that work; but there may be some one silly enough to claim that Impossibility No. 3 can be eliminated, and we will therefore show further that there is an even more serious Impossibility, No. 4, in the schedule.

It will be seen that the apparent purpose of the schedule was to make room for that *B* switch engine anyhow. But how is this effected? Not simply by scheduling trains to collide, *but also by shortening up the time for train movements to an entirely impracticable extent.* Tabulating the comparative schedules proposed, in comparison with the actual working of the trains as observed by Mr. Leverich, we have the following exhibit:

COMPARATIVE TIME REQUIRED IN PRACTICE FOR SWITCHING TRAINS, AND ALLOWED UNDER THE PROPOSED LEVERICH AND "DOT" SCHEDULES.

	Required in present practice as observed by G. Leverich.	Allowed under the proposed schedules of G. Leverich.		"Dot."
		Trains *A*.	Trains *B*.	
	seconds.	sec.	sec.	sec.
Unloading at platform	31.5	53	38	30
Switching to stub	**48.8**	**40**	**40**	**30** *or less*
Standing on stub	22.4	24	24	*none.*
Switching to loading platform	32.9	40	40	30 *or less*
Loading at platform	40.7	38	53	30
Total time in station	176.1	195	195	120
Range observed or allowed for irregularity of movement	161 to 194	*none.*	*none.*	*none.*

It will be seen that "Dot" proposes to make the switching movements in an absurdly short time, wholly unwarranted by precedent. It ought to be evident from simple inspection of the above table that this is wholly impossible, in view of the known fact that the traffic is now rushed as much as is possible, and that the time needed for the switching process fixes the limit of headway. But we will demonstrate affirmatively that it cannot be done much quicker than now:

It will be observed that in switching the trains back to stub an average of 16 seconds more is required than in switching them forward. Why is this? It is because (1) in switching them back the engine is in danger of running into a bumper, whereas in switching them forward the trains stop on an open track, and also (2) because in running out to switch the train starts out over 100-ft. reversed curves and has to be cautious, whereas in "kicking" the trains off the stub the track is both clearer and straighter. This difference of 16 seconds, therefore, represents a necessary excess for caution in running, and cannot be much abbreviated. Assume then that we could cut down the 49 seconds now used to 30 seconds, what would that mean? Plainly that the "kick" backward could be cut down by something like *the same number of seconds* (not merely ratio) or to (33—19 =) 14 seconds!

We have now fulfilled our contract to demonstrate affirmatively that two distinct impossibilities were involved in each of the two official explanations which have been attempted of how the traffic was to be doubled under the plan recommended by the second Board of Experts, which, we may repeat, is the same as that adopted by the Trustees three years ago in defiance of the recommendation of the first Board of Experts, and which we then declared to be absolutely unworkable for a number of reasons. Indeed, this last Board of Experts has gone farther (probably on the principle that while they were about it they might as well "go the entire animal"), and volunteers a certificate that the schedules which we have analyzed can still be adhered to with one more car per train, increasing the capacity 150 per cent., and can "probably" be adhered to even on an 80-second headway, increasing the capacity 181 per cent.! Such statements are merely the wildest folly, we care not from whom they come, and utterly discredit either the care or the intelligence or the good faith of those who make them. We say this not alone because of what we have already shown (which is enough to warrant them), but because there are half a dozen other impossibilities or absurdities which can be shown with equal ease. The situation makes us look on it as a public duty to fully expose these, in view of the determined fighting for bad plans, and for *one particular bad plan and no other*, which has gone on for nearly five years, and gone to lengths which the general public know little about. They will have a chance to know more about it after our next issue.

CORRESPONDENCE.

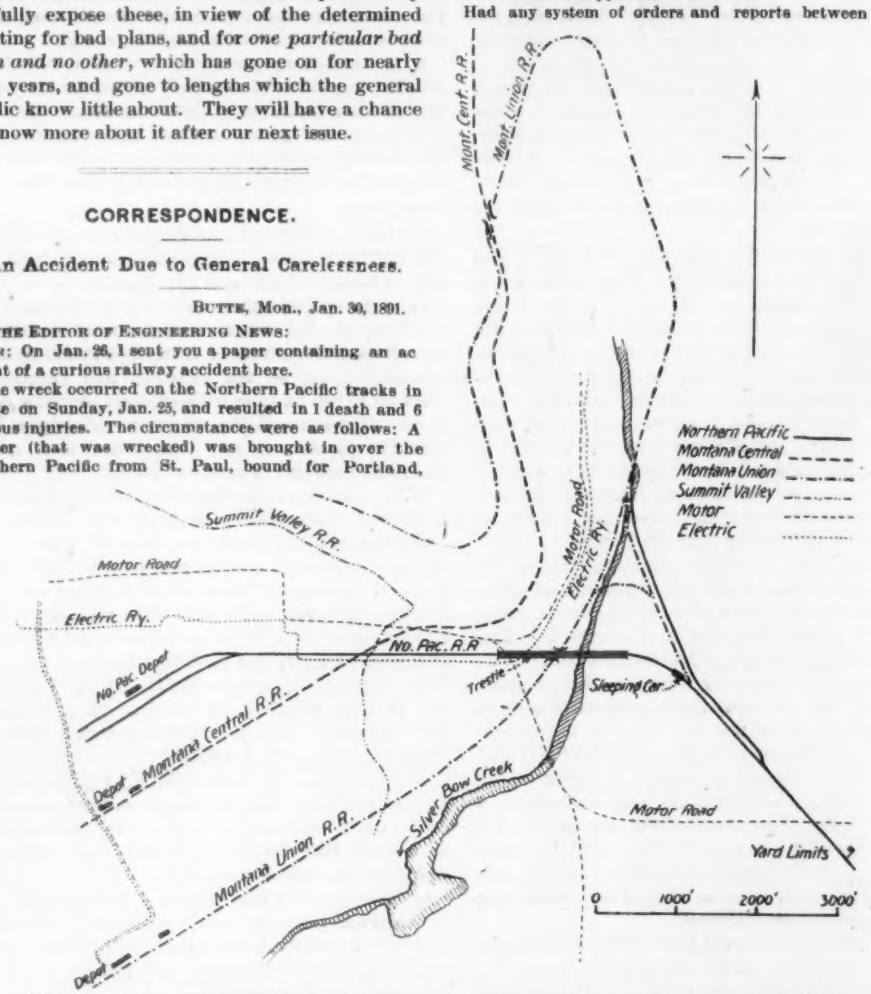
An Accident Due to General Carelessness.

BUTTE, Mon., Jan. 30, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: On Jan. 26, I sent you a paper containing an account of a curious railway accident here.

The wreck occurred on the Northern Pacific tracks in Butte on Sunday, Jan. 25, and resulted in 1 death and 6 serious injuries. The circumstances were as follows: A sleeper (that was wrecked) was brought in over the Northern Pacific from St. Paul, bound for Portland, and was left on the main track just beyond (east of) a high trestle to await switching to the Montana Union track over the connecting track shown at the east of the map, where it was to be attached to the Garrison train. While standing on the main track it was wrecked by a double-header Northern Pacific freight train, which was started eastward from the yards after the arrival of the passenger train, and which had attained a speed of between 15 and 20 miles per hour when it crashed into the sleeper. There were 8 passengers and a porter on the car.



MAP SHOWING ARRANGEMENT OF RAILWAY CROSSINGS NEAR BUTTE CITY, MONTANA

The car had been dropped, as usual, on the main track just beyond the Y, the usual practice being for the M. U. switch engine to run up and get the car, pull it back over the switch, and then run it north over the connecting track. The freight train was regularly scheduled to pull out to the east immediately after the passenger train arrived from the east. This was the first trip on the run of the leading freight engineer, and he did not know, he claims, nor did the other engineer, that it was customary to drop off a car in this way.

The freight train had just stopped at the grade crossings just west of the trestle, and was getting under way again, running without steam on a sharp down grade. There was a pretty heavy up grade beyond. There was a flagman out, but very close to the sleeper. It was his first trip on the run. Both engines had air brakes, but the cars had not. The conductor had been told by a passenger conductor that it was customary to drop off a car in this way. The switch engine was in the act of coupling to the car when the collision occurred. It was slightly damaged. There had been some trouble in coupling on the curve. The arrival of the switch engine had been somewhat delayed, but the usual routine had been followed in starting it out after the passenger train arrived.

It further appeared that there were no written rules about the interchange, but the understanding was that the N. P. road was to notify the M. U. if its train was late; otherwise the switch engine was to go out without notice. The passenger train was due at 1:55 P. M. and was on time. The freight train left about 2:05; the switch engine reached the car about 2:10 and the collision occurred about 2:15.

Had a clear understanding existed between these roads concerning the transfer of this car the wreck would have been less likely to occur.

Had the Montana Union been as prompt in removing the car as this arrangement would seem to demand, it would not have happened.

Had any system of orders and reports between the train dispatchers been in use, it would probably not have occurred.

Had the Montana Union crew and flagman who were handling the sleeper been active it seems as if the accident might have been averted, for the air was fairly clear.

Had the outgoing freight been in charge of men who were neither dead nor sleeping they should have been able to avoid it, for on leaving the N. P. depot, at a point about 2,500 ft. distant, they were required to stop at the Montana Central grade crossing. This, we are told, was done; 1,800 ft. beyond this point they entered upon a trestle 1,000 ft. or more in length, under which passes the track of the Montana Union and both steam and electric motor tracks from the city. The transfer station, as it is referred to, where the sleeper was left is but a few hundred feet beyond the end of this trestle.

When we reflect that the grade crossing, the trestle, the approach to the transfer station and the yard limits all combine to reduce the speed of this train to 4 to 6, or at most, 8 miles per hour over the entire distance it seems almost unaccountable that such an accident could happen. Has the plainest and most universal of railroad rules been complied with?

They should have received an order cautioning them on approaching the transfer, probably; but in the absence of all orders the plainest rules of good practice should enforce caution at every point on the run through the yard. The yard limit post is about one-half a mile beyond the point where the accident occurred.

Taken all in all, this "accident" furnishes an example of all-around carelessness and negligence that we may hope is seldom equaled.

JAS. H. HARPER.

Foundations.*

As an introduction to this subject, it can hardly be amiss to quote some exceedingly apt remarks upon it which were made in an address by that eminently practical engineer, Mr. JOHN B. JERVIS.† In advising young engineers as to designing works, he says: "It will be a practical question to determine to what extent expenses may go. In some works absolute stability and permanence are of high importance, especially if great inconvenience will arise in making repairs and renewals. The foundations, however, of *any* work should be stable, well adapted to support the weight of the superstructure and of permanent materials.

"This is a part that can rarely be renewed without taking down the whole fabric, and the engineer should be especially careful in this respect. A foundation should not be secured by unnecessary *expense*, as this would be a waste of means; but the engineer will be justified in doing something more than may appear necessary, rather than to fall below safety. If the foundation is exposed to surf or running water, especial care should be taken to guard against such action, or it may undermine the best work. The engineer who looks for eminence in his profession *must* study this branch carefully. It will not do for him to make his foundations inadequate, nor will he be justified in incurring unwarrantable expense. What he wants is enough for security, and his skill is to obtain that, and such excess as will provide for all contingencies which can possibly happen.

"Many small structures may fail, and be rebuilt without serious damage; but large works, that provide for the current and especially the daily wants of society, should have every reasonable protection against failure. The reason for this is obvious. Therefore, look well to your foundations."

It was my good fortune to listen to these words, and I give them as well worthy of remembrance.

Before proceeding, it may be well to note, for precision of thought, that the word "foundation" is used in two senses—first, of the strata built upon, and, second, of the substructure or artificial mass upon which a structure is to be reared. Taking these in their order, we have, as preliminary to every design, to investigate the character of the strata upon which we are to build. The extent of this examination will depend upon the weight and character of the proposed structure. For example, for a dam of the magnitude of the proposed Quaker Bridge dam, not only must rock be reached at every point, but it must be examined with the greatest care, in order to determine whether there are hidden seams or cavities which might develop dangerous leaks.

In most cases, it is sufficient to reach sound, undisturbed earth of a known quality. But this should always be penetrated to a sufficient depth, to insure that it is not underlaid by semi-fluid or compressible material, which may in time yield and cause trouble and danger. Sound judgment must also be exercised as to whether the removal of the upper strata by floods, or the building of other works to greater depths, may not in time cause movements in the strata underneath; strata which might otherwise be safely built upon.

Even quicksand is a good foundation when confined, but this confinement must be made sure. One of the most interesting cases on record of damage resulting from the movement of quicksand occurred in 1879 at the East India docks in London. About 700 ft. of the south wall settled, and in one place to the depth of 5 ft., with a bulge of 9 ft. at the toe. This settlement was attributed to work which was going on at the Midland docks, some 1,500 ft. away; and not until a "sand-blow" (or outflow of quicksand) at the latter point had been stopped did the settling of the wall cease. It seemed that both of the works crossed an ancient river bed, which had silted up and formed a very unstable foundation.‡

Another example well illustrates the necessity for examining even rock for hidden defects. The reservoir at Montrouge, for storing a portion of the water supply of Paris, was placed over a space known to have been more or less quarried out by tunneling, and the space filled in with rubbish. It was found that the supporting columns left were insufficient to support the proposed load; and, after much study, it was decided to build additional ones 5 ft. square, so distributed as to cover (with the columns already standing) a total of about 28% of the whole space. To trouble arose afterward from the weight of 29½ ft. depth of water, together with the massive two-storied masonry reservoir.‡

The methods used in examining the earth, etc., at the site of a structure, depend largely upon the depth to be penetrated. If on dry land the trouble is greatly less than in a tideway or a swift current. Simple methods of examination are: by sinking open test pits; by the use of an earth auger; by driving or forcing down with a jack a small open iron pipe and withdrawing it, thus bringing up samples of the strata passed through; also, by churning an iron rod up and down by hand, and judging by the resistance met and the feeling, the character of the earth beneath.

For greater depths tubes 4 ins. to 6 ins. in diameter are driven by a pile driver, using a wooden hammer, and the material within removed by a sand pump, or by passing down a smaller tube inside the larger one, and forcing water through the former, thus washing up the material. For rock testing the diamond drill has the great merit of furnishing a solid core of the rock passed through.

For the foundations of the East River Bridge three methods of testing were made use of. For the Brooklyn approach test pits were sunk. For the towers 6-in. iron tubes were driven to a depth of about 100 ft. below water surface, and the contents pumped out by the sand pump; the tubes being then withdrawn with a hydraulic jack. The New York approach passed over the region known as "The Swamp." Here 3-in. tubes were driven by hand, and a small sand pump used where needed. The depths to sound bottom were then plotted on a map, and contour lines drawn representing vertical distances of 1 ft. This gave at once the necessary depth of foundations. The greatest depth was 11 ft. below tide, making it necessary to pump 3,400 galls. per minute while building the first course of masonry in the pier at that point.

Although not quite *apropos* to the subject, the method employed in delineating the work done in removing the obstructions at Hallet's Point in the East River at New York may be interesting. Soundings were taken at very short intervals before beginning work, and an accurate model in wax made from them to scale. This was given a thickness which represented to scale at all points the actual thickness left in the roof of the excavations underneath and served as a cover, which, when removed, exposed an exact model of the workings below. As time went on each day's work was added, so that at all times the condition of the work could be seen at a glance.

In deep and navigable waters of any kind, or very rapid currents, the examination of the bottom is often a matter of considerable difficulty, requiring special appliances, but money thus expended is always a good investment.

Leaving this branch of our subject, we will now suppose that by some available method we have obtained a fair knowledge of the material upon which we are to form; we are then met by the all-important question, How much *load* can be safely imposed upon it per square foot of area?

This is necessarily a matter of experimental knowledge. We know that rock which is sound and free from seams or flaws will bear an unlimited load. We must, however make sure that it *is* sound, and we need also to determine its surface slope. If the slope be considerable, it may require the cutting of the rock into steps, thus involving considerable expense. Even after this is done there will be more mortar joints to undergo compression at one point than another, and more time must be allowed for the mortar to harden. Experiments are lacking as to the comparative compression of mortar freshly laid, and that of the age of 10 days or more. An examination I made some two years since of experiments at the Watertown arsenal and elsewhere, showed that under equal loads, neat Portland cement cylinders 28 days old compressed nearly twice as much as those 3½ months old, and 2½ times as much as those 6 months old.§

As an example of the initial compression in freshly laid mortar, I would mention one of the brick walls in the tower of the Produce Exchange building, in New York. The architect, Mr. GEORGE B. POST, states that a measured height of 9 ft. 6 ins. at the time of building compressed about one-half inch by the pressure of 62 pounds per square inch of base, induced by the finished wall, the whole having been built very rapidly.‖ In my own experience I have seen a tall, well-built brick wall, laid in rich cement mortar, warped perceptibly out of the vertical by placing a heavy load too quickly upon the floors.

The Watertown experiments on brick piers show conclusively an elastic reaction in good and well set masonry. We are therefore safe in founding upon a stepped base, if we can give time enough for the mortar to obtain a good proportion of its strength.

The question of compression in the joints of masonry, must also be considered in all masonry of great height, or that subject to heavy loading. Where the mass is not homogeneous, as in the case of stone facing an brick or rubble backing, the final result is very likely to be, that the stone, having fewer joints, will compress less, and will carry much more than its share of the load; and there will be spalling off at the angles and cracking of the stone.

This was the case at the new public buildings in Philadelphia, and also the lower part of the Washington Monument.

Another corollary is, that in joining new work to old, the foundation of the new should be made very broad, and the work carried up as far as is practicable without bonding with the old. In order to allow for compression in building the towers of the East River bridge, three courses below the cornice were left uncut until the height required to bring them to the proper elevation for the saddles could be determined with sufficient accuracy Even in earth work the slope of the underlying rock may be an important matter. On the West Shore road this slope was so great at one or two points that the bank built upon the earth slid off into the river, and it was found to be more economical to bridge the spaces than to attempt further filling.

The next materials to consider are gravel and sand. These are practically incompressible, but they should be rolled, rammed or puddled after being disturbed; and, as has been indicated, must be protected from change by washing or other cause.

I placed 10 tons upon the end of a 12 in. sq. stick of timber resting on a thick bed of very fine micaceous sand, in the New York caisson of the East River bridge, without causing perceptible settlement. Mr. MACDONALD allowed a pressure of 8 tons per square foot on the flanges of the disc piles supporting the first Coney Island pier.¶ The New York pier of the East River bridge rests on sand, with a pressure of 6¾ tons per square foot. The pressure under the piers of the New York approach to the bridge I made 3½ to 4½ tons per foot, and not a crack has been developed in 1,000 ft. length of masonry. The chimney of the steam heating station on Greenwich St., New York, transmit 4 tons per sq. ft. to the fine sand beneath.

Passing to clays, we have now to deal with a plastic material, which, under sufficient pressure, will flow both outward and upward. For example, Mr. MCALPINE found that the clay under the Capitol at Albany would bear 2 tons per sq. ft. at 3 ft. below the surface; but tons at 6 ft. down raised the surrounding surface RANKINE gives a formula for determining the saf load on various soils, but it must be used with judgment. Without multiplying examples, it would seem from experience that 1½ tons is a safe load per square foot upon clay, while failures have occurred at slightly over 2 tons. The piers of Westminster Bridge at London rested on gravel on a blue clay sub-strata, with a pressure of 5½ tons per square foot, but failed after many years.*

One of the most interesting examples of founding on a mixture of sand and clay is the building of the Washington monument. As first designed, when one-third built, the pressure at the base reached 5 tons per square foot. It remained in this condition for a number of years, and was then found to be 1¼ ins. out of plumb. The government engineers decided that the foundations must be enlarged sufficiently to reduce the load, when the monument was completed, to not more than 10,000 lbs. per square foot at the base. This was done by successively excavating and filling with concrete a series of narrow tunnels, thus extending the footings to the needed dimensions. It has been estimated that in a violent gale this pressure is temporarily doubled on the lee side, but no evil effects have yet resulted. In this connection it should be remembered that a mixture of sand and clay is quite a different material from pure clay; and the load, as it now is, may be entirely safe.

Among the more compressible materials, we come next to *silt* and *alluvium*. The most extensive experiments we have as to the bearing power of such strata were made by Mr. M. H. LEONARD,* M. I. C. E., on the Bengal public works in India. He found that brick piers transmitting 1 ton per sq. ft. to the alluvium at Calcutta caused practically no settlement; 2,700 lbs. per ft. caused settlement of about ¼ in., while 2 tons caused decided settlements. He found the least settlement to occur at about 4 to 6 ft. depth below the surface, and an increased settlement at either greater or less depths.† These are the most reliable experiments that I know of, for the reason that they were made on full-sized piers; and it is insisted upon by experimenters that absolutely certain results can only be reached when the area tested is approximately the same as that to be built upon. Neither is it safe to jump too quickly at conclusions, as the settlement is progressive and often continues for some time after the completion of a work.

In describing Fort Livingstone, which is on a sand island near the mouth of the Mississippi, Gen. BARNARD says:‡ "There were 20 ft. of a fine-grained, dark-colored sand, which was firm to the foot, resting upon a soft, plastic, slate-colored clay. The belief was held that so thick a stratum of sand would distribute the load and prevent material settlements. It was found, however, that during the building of the fort the great load carried the whole mass down from 2 to 3 ft., followed subsequently by a further settlement of 1 to 2 ft. Fortunately the great thickness of the sand prevented abrupt transitions in amount of settlement, and no serious dislocations occurred."

The more recent case of the government building at Chicago is an interesting one. This was built about 14 years ago, and recently the government superintendent of buildings, Mr. W. BELL, has stated that during the last 13 years it has settled 6 to 18 ins., and the movement was still progressing.§

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* Lecture delivered before the students of the Rensselaer Polytechnic Institute by F. COLLINGWOOD, C. E., and reprinted from *The Polytechnic*.

† Trans. Am. Soc. C. E., vol. 1, p. 139.

‡ *Engineering*, London, vol. 31, p. 403.

‡ *Engineering*, London, July 19, 1878.

§ Trans. Am. Soc. C. E., vol. 18, p. 270.

‖ Trans. Am. Soc. C. E., vol. 14, p. 491.

¶ See Trans. Am. Soc. C. E., vol. 8, p. 227.

* Major Delafield on "Foundations in Compressible Soils," 1868.

† *Engineering*, London, Vol. 29, p. 103; ENGINEERING NEWS, Vol. 31, p. 116.

‡ See Trans. Am. Soc. C. E., Vol. 9, p. 324.

§ See ENGINEERING NEWS, Oct. 18, 1890.

The best practice in founding at Chicago, on the compressible soils prevalent there, seems to show that loads up to nearly 2 tons per sq ft. are safe; but that beyond that the results are uncertain. It is possible that when large areas are covered this load may be safely increased. Under the safe load mentioned there is a settlement never exceeding 4 to 5 ins. and it ceases in about three years.

The Tay Bridge in Scotland is founded on a silty sand. The piers transmit to the sand, when loaded to a maximum, 3 to 3½ gross tons per sq. ft. After sinking they were loaded temporarily with additional weights, such as to make a total load of 5 to 5¼ tons per sq. ft., which was allowed to remain from 6 to 25 days. The additional settlement thus caused at various piers was 1¼ to 1¾ ins.‖

At the site of the Paris exhibition buildings the surface soil is gravel, underlaid by stiff clay. The loads there adopted were about 6,000 lbs per sq. ft, where the gravel was 10 ft. thick, and 4,550 lbs. when between 5 ft. and 10 ft. When the thickness was less than 5 ft., piles were driven. At one point tested, a load of 8 tons per foot caused a settlement of 11 ins. in twelve hours, while 6 tons was borne safely.¶

At the site of the Hudson River tunnel at New York the mud on the Hoboken side is of great depth, but is compact and tenacious. Gen. SOOY SMITH found that this material would barely support a load of 5,580 lbs. per sq. ft.

As an example of the most compressible of all soils, I would refer to the peaty soils in Holland. Observations made near Amsterdam showed that a bank of sand 8 ft. high (or a load of say 800 lbs. per sq. ft.), compressed the peat underneath to two-thirds its bulk, and a state of rest was not reached under about two years. The bank afterward bore safely the railroad traffic over it.* To save unnecessary filling by displacement of the soft earth, the ground was given a convex cross section, and covered with a fascine mattrass. The sand was uniformly spread so as to retain the convex form, and wattlings were used at the sides to keep the sand from spreading.

On the same railroad line, in preparing a station yard, the space was surrounded by a trench 15 ft. wide and 15 ft. deep, which was filled with sand, and the whole surface covered with sand to a depth of 3 ft. Station buildings were also founded on sand filled into pits to a depth of 15 ft., and extending beyond the buildings about 20 ft. in all directions. In all these cases the particles of sand lock together much like a pile of cannon balls, and transmit the pressure imposed to an area which increases much more rapidly than the depth.

It was a matter of great interest to me to find in the fourth memoir of the Egyptian exploration fund (1888) that in founding their temples on the Nile alluvium the ancient Egyptians made use of this method. Mr. PETRIE, in describing it, says: "First a space, each way a foot or more larger than the intended building, was marked out, and a wall of crude bricks built around it. In some cases the space was excavated in hard rammed mud, and the bottom of the space was quite hard and level. This enclosure thus formed a sunken chamber, which was partly filled with clean desert sand, and on that sand the building was placed, standing clear of the retaining walls of the foundation, with either a few inches or 2 or 3 ft. of sand filled between its foundation courses and the walls." He then goes on to say that he had found the sand under the foundations with depths from 2 ft. up to 8 ft. and more.

As an example of the extreme compressibility of light river silt, Mr. SCHMIDT, who was Assistant Engineer on the jetties at the mouth of the Mississippi, states that the compression of the bottom at the outer end of the jetties was about 70% of the total bulk.†

I have been particular to give these details because the young engineer will meet the need of just such information the first time he begins a work, and it is scattered everywhere through the records of existing works.

(To be continued.)

‖ ENGINEERING NEWS, Vol. XVIII., p. 90.
¶ *Engineering*, London, Vol. XLV., p. 420.
* "A Sketch of the Public Works in the Netherlands, by Lieut.-Col. L. C. Van Herkwyk," 1876.
† Trans. Am. C. E., vol. 8, p. 199.

The Second Expert Report on the Brooklyn Bridge.

A correspondent who signs himself "Dot" contributes to the last issue of the *Railroad Gazette* a communication under the above heading, which we reprint in full below, in which he attempts to impeach the correctness of this journal in declaring, as it did, in its issue of Jan. 24, that "the second Board of Experts has recommended, not simply questionable or hazardous procedures, but physical impossibilities; impossibilities as certain, if not so transparently evident, as if they had recommended with equal gravity that three pints be carried in a quart pot."

"Dot" modestly declares in this communication: "My testimony can add no weight to the opinion of the Board," and we agree with him. It is likely to have a contrary effect; for the method of operating which he pretends to outline is a transparent absurdity, good enough (it now appears) to impose on those who read with the eye only, and not the understanding, for the *Railroad Gazette* cordially indorses it as "so simple that it may be followed by any one," but in fact outlining a method of handling trains so impossible that it would seem as if even the most careless reader could not be deceived by it. Nevertheless, "Dot" claims to speak by inspiration, and as one having authority. This method, and no other, according to "Dot," is that which the engineering staff of the Bridge submitted to the late Board of Experts, and which that Board indorsed, for obtaining an alleged double capacity. It differs radically from the schedule which Assistant Engineer G. LEVERICH, of the Bridge staff put forth about a year ago in a pamphlet on the subject, but both these schedules alike are for different reasons demonstrable absurdities. We discuss them both in detail in another column, and we have further concluded that while we are about it we may as well make a clean thing of a disagreeable job, and show up all "The Bottom Facts of the Brooklyn Bridge Question" so far as they are known to us, which is a good deal further than has yet appeared from our columns. A part of this task we must postpone to a following issue. The following is "Dot's" communication:

ENGINEERING NEWS states in its issue of Jan. 24 that in proposing to reduce the headway of trains on the Brooklyn Bridge to 45 seconds by the Barnes-Martin plan of tail switching, "the Board of Experts has recommended not simply questionable and hazardous procedures, but physical impossibilities."

I have made careful inquiry into the methods which the Board proposes to employ, and have satisfied myself by personal observation that by means of these methods the headway of four-car trains can be reduced to 45 seconds. My testimony can add no weight to the opinion of the Board, but I beg your attention to the accompanying diagram and explanations, which, though less ingenious than those of Mr. LEVERICH, will possibly be more easily understood by the general reader.

Trains from the bridge are delivered alternately to the right and left of the incoming platform. In practice they are run in pairs, with intervals between trains of 20 seconds and 70 seconds, alternately. After discharging their passengers, the trains are taken to the outgoing platform in the following manner by engines *X* and *Y*. Train No. 1 arrives at *B* and stands 30 seconds to discharge passengers, and during this time *Y* couples on at *B*.

Twenty seconds later train No. 2 arrives at *A* and stands 30 seconds to discharge passengers, engine *X* meanwhile being coupled on at *A*. Ten seconds after the arrival of train No. 2 at *A*, engine *Y* pulls out with train No. 1 to *K*, using 30 seconds or less, and then "kicks" the train to *D*, using 30 seconds or less.

Twenty seconds after the departure of train No. 1 from *B*, engine *X* pulls out with train No. 2 from *A*, and runs to

H, using 30 seconds or less, and then "kicks" the train to *C*, using 30 seconds.

After kicking the trains 1 and 2 to the outgoing platform, both engines stop before reaching the switches *G* and *F*, and, as soon as train No. 2 is clear of the crossing *E*, the engines pass respectively to *B* and *A*.

Thus train No. 1 has consumed 30 seconds in unloading, 30 seconds in passing to *K* and 30 seconds in passing to *D*; but add to this 15 seconds that engine *Y* has to wait at *G* for train No. 2 to clear the crossing *E*, and we have a total of 105 seconds.

Now train No. 3 arrives at *B* 90 seconds after train No. 1, so that No. 3 has been standing 15 seconds before engine *Y* has a clear track to *B*. But it requires 30 seconds to unload, so there are 15 seconds left in which to pass engine *Y* from *G* to *B* and couple to train No. 3, an operation which requires less than five seconds. Of course train No. 4 is delivered at "*A*" 20 seconds behind train No. 3, and then the same switching movement is gone through with as with trains Nos. 1 and 2. At the outgoing platform each train stands 30 seconds to load and then departs.

Now one word as to the safety of this plan. As has been stated before, no loaded trains use the crossing. Moreover, the crossing *E* is interlocked with *F* and *G*, so that *F* and *G* cannot both stand for the crossing at the same time, and the crossing cannot be taken from one or given to the other till it is entirely clear. It is also evident that there is the less danger of accident in that the movements of the two engines are for the most part in parallel lines. The running of trains in pairs will have another great advantage, since it will admit of loading from both sides of the outgoing platform at one time. The interval during which no trains are standing at this platform will be sufficient to allow the crowd to distribute itself evenly over the entire length of the platform, so as to pass easily through all the gates, instead of choking up those at one end of the trains.

The *Railroad Gazette* comments upon this communication as follows. We reprint it, as we shall have occasion to refer to certain sentences which we have put in italics. We will say right here and now, however, that the statement italicized below as to the procedures of the first Board is to our certain knowledge a slanderous misstatement of the facts:

The letter of our correspondent in another column *shows in a simple manner, which may be followed by any one*, the method by which the increased number of trains which the later Board of Experts *has suggested as possible* may be switched and moved over the Brooklyn Bridge, when the moderate changes which the Board has recommended shall have been made. Probably the conclusions of the Board as to the increased accommodations which could be thus afforded would have been generally accepted upon the report of the Board, because of the confidence in the judgment of its members felt by all who know them, had not their calculations been impugned by one of our contemporaries, *of which the Editor-in-Chief had submitted to the Board a competitive plan for the Bridge termini*, and whose opinions would, therefore, have weight as those of an engineer who had studied the questions involved. *Yet we are compelled to believe that prejudice has led him to consider them chiefly from the side of his own scheme, or from the interior of his office, being unable or unwilling to adopt any other point of view.* For we may conceive the loop to be the most desirable terminal arrangement, if it can be made practicable, while we admit the justness of the calculations which show that the capacity of the Bridge to transport passengers *may be doubled without any loop. It will not do for one so accustomed to use graphical demonstrations as is our contemporary to sneer at the diagrams of* MR. LEVERICH *and to call them, as he does, only ingenious looking. Such diagrams should be met by showing wherein they are wrong, if they are so.* In considering the report of the second Board, we are, of course, confronted by that of the first Board of Experts, which differs from it in a manner not to be accounted for *by those unacquainted with the fact that the first Board ignored altogether the teachings to be derived from the experience in operating the Bridge which had been acquired by its officers, preferring to attack the questions, presented for their investigation from the outside, as problems requiring for their solution only an ordinary acquaintance with transportation matters.* The new Board seems to us to have acted wisely in consulting with the only persons who have ever had an opportunity to become acquainted in a practical way, with the problems peculiar to this bridge only, some of which are of a very grave character. We do, ourselves, hope and believe (*as no doubt the members of the recent Board of Experts do*, else they would not have recommended experiments to be made with the loop), that some scheme of moving the bridge trains in a cycle, following one another without switching, may be developed which will be safe and useful; yet *we applaud the prudence of the Board which causes it to recommend for adoption only a method which cannot interrupt the present enormous traffic of the bridge.*

MR. WELLINGTON, of this journal, sent the following communication to the *Railroad Gazette* in partial answer to the statements above. It appears in the current issue of that journal:

TO THE EDITOR OF THE RAILROAD GAZETTE: As you state in your last issue that a correspondent, who signs himself "Dot," "shows in a simple manner, which may be followed by any one," that certain conclusions which were expressed in the journal of which I am one of the editors were incorrect; and as you further go on to refer to myself as an individual in your comments, correctly stating that I have myself prepared and submitted for consideration plans for the bridge termini, and adding: "We are compelled to believe that prejudice has led him to consider them [the bridge plans] chiefly from the side of his own scheme," permit me to state:

1. The methods of handling the traffic which "Dot" declares to be "the methods which the [Board of Experts] proposes to employ," propose to accomplish not one only but two different and distinct physical impossibilities, viz.:

(*a*) They propose to switch trains back from the incoming platform to the stub switch in 30 seconds, when Mr. LEVERICH himself shows (p. 27 of his pamphlet, "Traffic Capacity of Brooklyn Bridge") that this operation requires an average of 48.8 seconds, varying in 20 successive observations between the wide limits or 45 seconds as a minimum and 63 seconds as a maximum. These limits I have this week ascertained by still more extended time observations to be substantially correct, and it is this limit which fixes and controls the headway of trains, which has never been reduced successfully below 85 to 90 seconds. The total time allowed for the whole movement of the train from entrance to departure is only 120 seconds, whereas the table above referred to shows that 176.1 sec-

onds (varying in 20 successive trips from 161 to 194 seconds) is now required to work even a single system.

(*b*) They propose the further impossibility that two trains shall occupy the same space at the same time, the rear car of train *B* running out to the stub and the head car of train *A* backing down from the stub to the outgoing platform, coming into collision every 90 seconds, even if on time to the second.

Permit me to state further:

2. The diagrams of Mr. LEVERICH, to which you refer in the same connection as if showing the same system of handling the trains as that announced by "Dot" are based upon an entirely different schedule, allowing 195 seconds for the total movement for which "Dot" allows only 120 seconds; and they propose to accomplish two other and entirely distinct physical impossibilities, of such a nature as to make it clear that the necessary allowances of time for the movements of the *B* switch engine (marked *Y* in your diagram published last week) was wholly overlooked; viz.:

(*a*) The schedule requires that the *B* engine shall be in two different places doing two different things at one and the same time, viz.: At the rear (west end) of train B^1 kicking it back to the outgoing platform, and at the front (east end) of train B^1, running over the crossing to couple on to train B^2.

(*b*) The schedule further requires, even if this miracle were performed, that the trains, the process of unloading and the movements of the switch engine shall be all on time to the second or collision will result, and if so on time, the engine must be in motion toward the crossing before train *A* has cleared it.

These facts you will discover by carefully going over the movements of the trains on the respective schedules, guided by this statement of the specific points of difficulty; or if not, you will find them pointed out in detail in the forthcoming issue of ENGINEERING NEWS, by the aid of the graphical methods which you justly state I am accustomed to use.

A. M. WELLINGTON.

Feeder Railways in India.

An article in *The Indian Engineer*, of Calcutta, Jan. 3, states that the extension of railways in districts which already have railway accommodation is being overdone, and that in consequence the receipts on many important lines are unsatisfactory, while there does not appear to be much chance of any substantial improvement for some time to come. More attention should be paid, it is said, to districts which are as yet unprovided with railways.

Lines which run through fertile and well populated parts of the country are always sure of a fair amount of local traffic, but even this, in many cases, is drawn from other railways in the vicinity, and the total amount of traffic earnings is very slightly augmented thereby. Railways which have to depend entirely upon through traffic are not only liable to be affected by failure of crops, the fluctuations of the export trade and other causes beyond the control of the staff, but have sometimes to compete with other lines which can, owing to more favorable gradients, cheaper coal, etc., carry goods at a lower cost, although the route to be traversed is considerably longer.

What we now require are feeder lines or short branches connecting the main lines with all large marts or agricultural centers within a reasonable distance; we understand that several such lines have been suggested lately, and that, in some cases at least, it is proposed to construct them of a much narrower gage than the trunk lines with which they are to be connected. This would be a fatal mistake, as it would involve the cost of transhipment at the junction, and thus entail an additional charge of 4 annas (12 cts.) at least on every ton of goods carried. That the evils of a break of gage are intensified in proportion to the shortness of lead has already been clearly shown by the correspondence on the relative merits of broad and metre gage lines of railway published by the Indian Government, and as, in most cases, the feeder lines required would not exceed 25 miles in length, while in some parts of the country 10 or 12 miles would be the average, it is to be hoped that no change from the standard gage will in any case be permitted, since, in addition to the cost of transhipment, there is certain to be a loss of at least 12 hours in forwarding consignments; and frequent handling of goods means loss of weight, damage to packages, and other evils too numerous to mention. So far back as 1862 the Indian Government decided that all railways intended to form portions of main lines were to be built on the 5 ft. 6 ins. gage, but at the same time they consented to the Nalhati branch being built of a narrower gage as a temporary expedient, being convinced that such lines would be replaced by full-gage lines of a more substantial character whenever the development of the traffic rendered such a change advisable. After causing serious inconvenience for more than a quarter of a century, the Nalhati branch is now to be relaid with heavier material and will be of the same gage as the East Indian Ry., of which it will form a portion; but there would not have been any great difficulty in, and the cost would not have been very materially increased by, laying the same materials to the 5 ft. 6 ins. gage when the line was first constructed. This would have enabled the loaded wagons of the East Indian Ry. to run over the branch instead of trans-shipping the goods at Nalhati, thus saving time, expense and rolling stock.

It is not necessary that the permanent way of feeder lines should be of an expensive type, or that heavy expenditure should be incurred in erecting large stations. Rails weighing 40 lbs. per yd., laid on second-hand wooden or light iron sleepers, would be quite sufficient to carry the heaviest wagons now in use at a speed of 12 or 15 miles per hour, and there would not be any difficulty in designing tank engines which would, when in full working order, weigh no more than a loaded wagon. Locomotives weighing only 25 tons are now in use on several railways, and would be quite capable of drawing the light loads required on feeder lines, and there is therefore no excuse for spending large sums on expensive permanent way until such time as the traffic to be carried warrants additional expenditure on way and works. Commodious goods sheds can be built of scrap rails and corrugated iron at a reasonable cost, and buildings of this sort can be taken down at any time and rebuilt wherever required.

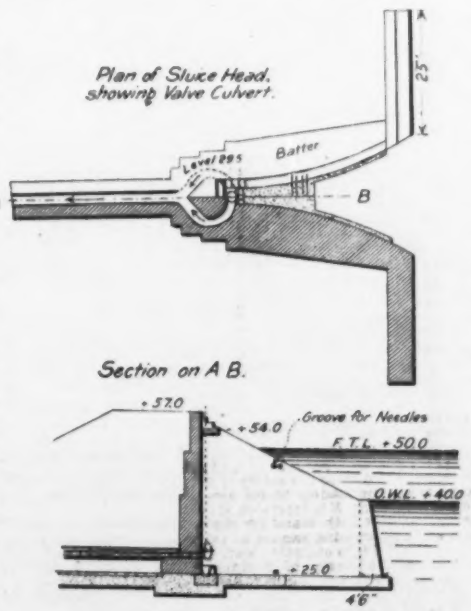
In America light lines of railway are often built and worked for years until the volume of traffic justifies a larger outlay, and the line is then relaid with heavier material by degrees without interfering with the running of trains. The same procedure could be introduced with advantage in many parts of India, and by following the natural surface of the country as much as possible, and avoiding expensive bridges, the cost need not be more than Rs. 26,000 ($13,000) per mile for the broad gage, and in many cases much less, as the landowners would willingly make a free grant of the land, and the staff already employed in maintaining the running line could supervise the construction, etc., without incurring any extra expense. Some years ago when referring to light railways in England, Sir CHARLES TREVELYAN said: "Cheap agricultural railways are now being made in various parts of the country, but they are all solid, full-gaged railways quite capable of bearing the rolling stock of the main lines with which they are connected."

More than one instance of country carts competing successfully with railways has been reported during the past few years, but by careful management and the exercise of a little tact, railway officials should be able to hold their own against all comers and command whatever traffic has to be carried. The goods tariffs should be simplified as much as possible and all unnecessary restrictions removed; in fact, every villager should be made to understand that the railway is one of his best friends and that every reasonable assistance will at all times be given to any one requiring to use it for the carriage of goods and passengers.

The construction of feeder lines would certainly result in large tracts of land, which are now lying idle, being cultivated, as it would enable both land owners and merchants to despatch their stock of grain at any time of the year instead of waiting until the rains are over and the roads have been repaired.

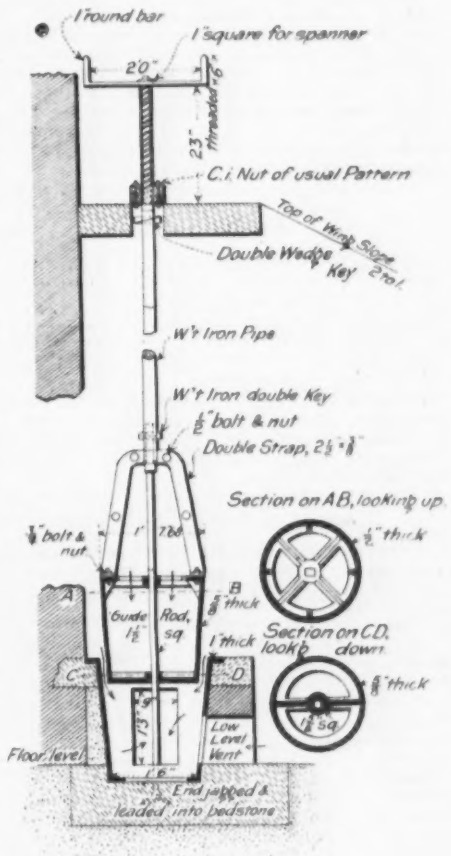
Tank Sluice with Equilibrium Valve.

Indian Engineering, of Nov. 22, 1890, contains a description of a tank sluice with an equilibrium valve, designed by Mr. G. C. LARMINIE, A. M. Inst. C. E., which is here reproduced in its essential features. The purpose of the designer is to avoid the troubles incident to the ordinary native method of regulating the flow from tanks by means of plugs at various levels.



The use of shutters worked by screws is only convenient between certain limits, as a shutter of small area, say 2 × 2 ft., under 25 ft. head of water would require a powerful screw and several men to work it. The idea of equilibrating sluice shutters is believed to have originated with Mr. F. M. G. STONEY, M. I. C. E.; but his gear was not cheap and simple enough for use with ordinary tank sluices.

The arrangement here proposed includes a hollow, slightly conical cast-iron plug, open at the top and bottom. Cast-iron is used as the most convenient



Details of Valve.

The plug is made slightly conical to facilitate its passage into the plug chamber; though the nearer cylindrical the plug is made the less will be the vertical component due to water pressure. As here designed, the total pressure distributed all around the sides of the plug, from 25 ft. of water, would be 6 tons. If this is supposed to be concentrated at two opposite points on the circumference, a diagram will show that the vertical component is about 515 lbs., and adding to this the weight of the plug and lifting rod, the total to be raised is about 815 lbs.

As described, an ordinary rising screw of just the right length, is keyed to a wrought iron pipe; the latter is in turn keyed to the short length of rod which revolves in the collar attached to the top of the plug. The guide bar is square, to prevent the plug from revolving, and is leaded into the bed stone at the bottom of the sluice chamber. The discharge can be regulated to a nicety by the lift of the screw.

The plug chamber is a light conical casting, with flanges as shown, with the upper flange leaded or bolted to the stone and the lower end set in cement. The two discharge openings in this chamber are each 15 × 9 ins., and opposite to each other. These vents lead into passages built in the masonry and faced with stone, and conduct the water to the main channel, as shown on the plan.

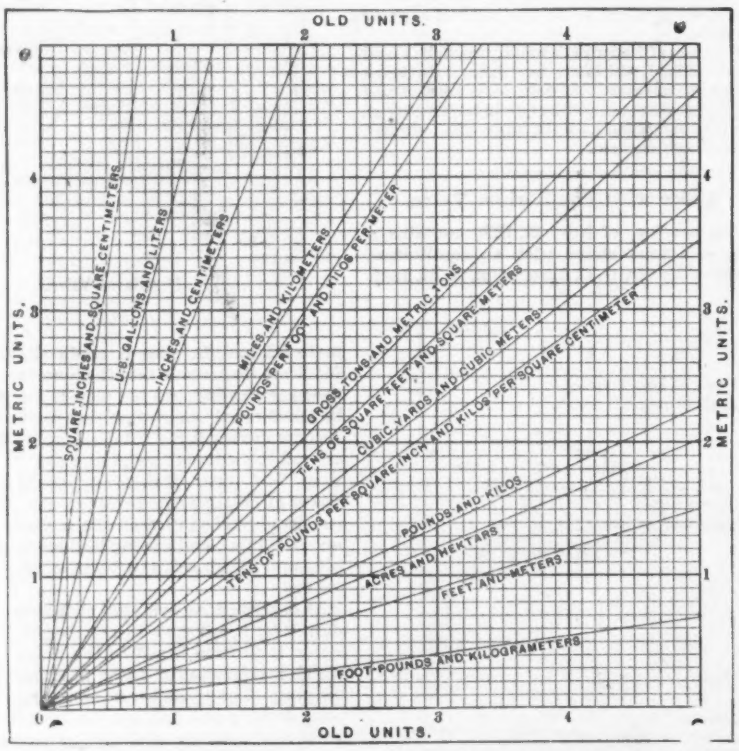
For absolutely water-tight work the plug and its chamber should be turned, either over its whole surface or in rings. But for most purposes in India, this accuracy of fit is not required. The plug and chamber will admit of greater area of vent than those shown. The cost of the plug castings is given as equivalent to $57.50 of American money.

A Steam Carriage.

A steam phaeton has been introduced into Paris by M. SERPOLLET, the inventor of an inexplosible steam boiler of small dimensions. It resembles an ordinary phaeton, and has, under the body of the carriage, a Serpollet motor, with an inexplosive boiler and a funnel bent down to discharge the smoke under the hind seat of the vehicle. It is guided by a single front wheel, after the manner of a tricycle. As the Prefecture has authorized the police of Paris not to interfere with these carriages so long as they do not exceed a speed of 16 kilometres, (about 10 miles) an hour, it will be well to consider some of the details. The tank is capable of holding enough water to perform a journey of 18 or 20 miles; the bunker can furnish fuel (preferably coke in cities, as it is smokeless) for running 36 miles. The weight of the vehicle with water and coke is 1,250 kilogrammes, of which 70 are fuel and 90 are water. The engine is of 4 HP., rising to 6 HP., and can be controlled to give several speeds, slow and fast. On a good country road a speed of 15 miles an hour can be kept up with seven persons in the carriage. It can be started in 20 minutes, and the feeding of the engine with water and fuel goes on automatically. The stopping, steering and slowing are easily managed by the driver on the front seat.—*Contract Journal.*

Diagram of Metrical Equivalents.

By request we republish a very neat diagram of metrical equivalents, which has been found exceedingly useful in converting metrical and old units where extreme accuracy is not required. Its use is patent to every one, and larger diagrams can be made from it to suit special cases. This diagram is adapted from one appearing in a German periodical by, we believe, Mr. FRED. BROOKS, of Boston, Mass.


OLD UNITS.
METRIC UNITS.
SQUARE INCHES AND SQUARE CENTIMETERS
U.S. GALLONS AND LITERS
INCHES AND CENTIMETERS
MILES AND KILOMETERS
POUNDS PER FOOT AND KILOS PER METER
GROSS TONS AND METRIC TONS
FEET OF SQUARE FEET AND SQUARE METERS
CUBIC YARDS AND CUBIC METERS
TONS OF POUNDS PER SQUARE INCH AND KILOS PER SQUARE CENTIMETER
POUNDS AND KILOS
ACRES AND HEKTARS
FEET AND METERS
FOOT-POUNDS AND KILOGRAMETERS

Engineering Trades Report for England.

Messrs. Matheson & Grant have issued their regular half-yearly engineering trades report for England, dated London, Jan. 1, 1891. A general resumé of this report is as follows: The year 1890 was the most prosperous since 1873, and the present activity is still in operation and likely to last, subject to certain contingencies, for some months to come. The engineering trades in England are particularly dependent on foreign enterprise, and the South American troubles are now an immediate cause of depression. The advance in the price of wages in the collieries and the more than corresponding advance in the selling price of coal has severely hampered the engineering trades. The trade in pig iron is in a depressed condition, and prices are low, if judged by the cost of fuel and labor. This trade has been unduly influenced by speculation, which produced artificial fluctuations. The prices of rolled iron are also much below those which generally belong to an active condition of the engineering trades. This may be taken as a sign that while the shops are busy there is already a falling off in new orders.

The steel manufacturing capacity of England is so large as to keep down prices notwithstanding the great consumption. Rails, from 70 to 90 lbs. per yard, have been ranging, within narrow limits, about £5 per ton for the last few months. Lighter sections of rail are from 10s. to 40s. dearer, and there is no likelihood of an advance. Siemens' steel ship plates sell at quite unremunerative prices, say the makers. German competition is felt in the manufacture of I-beams and other structural iron. Sheffield steel is doing well.

The following table is given of fluctuations in prices during the last five years:

	Per ton.						
	Jan. 1886.	Jan. 1887.	Jan. 1888.	Jan. 1889.	Jan. 1890.	July. 1890.	Jan. 1891.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Steam coal, f.o.b. at Cardiff	0 9 6	0 8 6	0 9 0	0 13 0	0 14 0	0 15 0	0 15 0
West Hartley coal, f.o.b. at Newcastle	0 8 6	0 8 0	0 8 0	0 9 0	0 12 0	0 13 0	0 12 0
Pig iron at Glasgow, No. 3	2 1 0	2 4 6	2 3 0	2 2 6	3 3 0	2 6 0	2 6 6
Pig iron at Middlesbrough, No. 3	1 11 6	1 14 0	1 13 6	1 14 0	3 2 0	2 3 0	2 2 6
Iron ship plates at Middlesbrough	4 12 6	4 12 6	4 15 0	5 12 6	8 5 0	5 10 0	6 0 0
Iron bridge plates	5 17 6	5 7 6	6 0 0	6 10 0	8 10 0	6 10 0	7 0 0
Steel bridge plates	6 17 6	6 5 0	7 0 0	7 10 0	9 10 0	7 0 0	7 10 0
Steel rails, f.o.b.	5 0 0	4 5 0	4 3 0	4 2 6	7 0 0	5 0 0	5 0 0

The builders of locomotives and rolling stock have been fully occupied in sharing in the demand from abroad and in meeting unusually large orders from home. But no new works have been started. The projected works in New South Wales have not been established. The report says that the growth of similar works in the United States is driving private firms to rely more on foreign trade, and they are active competitors for Central and South American trade.

The leading shipbuilders are now busy, and employment is assured for the next few months; but freights are low and steamers are being laid up, and the summer outlook is unfavorable. During the year, 1,271,000 tons of shipping were launched in Great Britain. This is slightly less than in 1889.

THE WEIGHT OF RAILS AND SPIKES required per mile of track for various weights of light rails is given in the following little table, sent us by H. K. Porter & Co., of Pittsburg:

Rails.		*Spikes.*	
Wt. per yd., lbs.	Wt. per mile, gross tons.	Size ins.	Wt. required per mile, lbs.
16	25¼	3½ × ⅜	2,000
20	31½	3½ × ⅜	2,000
25	39½	4 × ½	3,000
30	47½	4 × ½	3,000
35	55	4 × ½	3,600
40	62½	4 × ½	3,600
45	70½	4½ × ½	4,200
56	88	5 × ⅝	5,200

With reference to hauling capacity of light locomotives on grades, they say that a locomotive with 10 tons on the drivers (cars and rails being in good condition) will haul 500 tons on a level. On grades it will start and haul as follows:

1% grade,	130 tons.	1½% grade,	90 tons.
2% "	70 "	3% "	45 "
5% "	25 "	8% "	10 "

The above figures give a little less than half the loads which a very light American type locomotive with 14 × 24-in. cylinders and 20 tons or double the weight on the drivers can haul under the conditions named above. Many of the small locomotives built by H. K. Porter & Co. have been working regularly for years on curves of less than 25 ft. radius.

THE NEW HAVEN BREAKWATER, now under contract, is to be about 1,400 ft. long and 38 ft. in average height. It will complete the system of breakwaters planned some years ago, and is to cost about $1,500,000. Stone is now being delivered for it at the rate of 400 tons per day. The East breakwater, already built, has increased the channel depth from 16 to 19 ft.

AN ARMOR CONTRACT, amounting to 6,000 tons, worth $3,500,000, has been made with Carnegie, Phipps & Co. The government made a contract, in 1887, with the Bethlehem Iron Works for an almost equal amount; but an additional source is necessary to supply the 14,000 tons now needed. The Bethlehem works will not commence turning out armor until next September. The Carnegie Co. says that it can commence delivery in June, 1891, and continue at the rate of 500 tons per month.

COLD AIR PIPES are the latest addition to be made to the complications already buried under city streets. The Economy Refrigerating Co. has been incorporated under the laws of New York State, and is now asking permission to lay its pipes under the streets of Brooklyn. This company proposes to furnish means of refrigeration by gas from ammonia. This system is already in use to some extent in New York, and we understand that quite an area about Warren St. is so supplied.

A BILL FOR MAKING SOUNDINGS IN THE PACIFIC from San Francisco to Honolulu is now before Congress. The naval committee favorably reports the amendment to the naval appropriation bill, setting aside $50,000 for this purpose.

A FIRE IN THE SHAFT OF THE CHAPIN MINE at Iron Mountain, Mich., was recently extinguished by extending four lines of hose from the city hydrants to the mouth of the shaft and pouring water down for 11 hours. The water-works are not yet completed, but small temporary pumps have been in operation for several months, and a 550,000 gall. tank was filled with water, thus providing a supply sufficient for the emergency. The works are being built by Mr. W. R. COATS, under a franchise. Mr. COATS informs us that in all water-works construction he makes a practice of providing temporary pumps and keeping the mains filled as fast as laid, thus furnishing a limited fire service until the elevated reservoir, which forms a part of his system, is completed, after which the water stored in the reservoir is sufficient for quite satisfactory protection during any ordinary conflagration, at least. At Iron Mountain a quite extensive domestic service was rendered by the aid of the temporary pumps and the storage tank.

PHOTOGRAPHING IN COLORS is again announced as discovered. M. LIPPMANN, Professor of Physics at the Sorbonne, says a cable dispatch, claims to be able to reproduce by photography the colors of the solar spectrum, as accurately as the outlines or shadows are now fixed upon photographic negatives. He does not claim, however, that his discovery has at yet passed beyond the experimental stage.

A PACIFIC CABLE CO. BILL has been introduced in Congress by Senator MITCHELL. The company which is thus to be incorporated is to lay a cable from San Francisco to Honolulu; thence, via Samoa, to New Zealand and Japan. If the cable is laid within two years of the approval of the act the Secretary of the Treasury is authorized to pay to the company $200,000 annually for 15 years. The cable must be maintained in good working order and transmit 14 words per minute at a charge to be

fixed in the bill. Government messages are to be free and have preference. The capital stock is placed at $5,000,000, and bonds $5,000,000.

A 32-STORIED BUILDING, 442 FT. HIGH, is proposed by Mr. BRUCE PRICE, an architect of New York. The "study" for this building was published in the New York *Sun* of Feb. 8, and shows a structure 442 ft. high on a plot of ground 75 ft. square. As described, the foundation would cover the entire building area with the total weight equally distributed over it; bed rock is to be used if available, otherwise piles, concrete and an iron grillage would be substituted. Following modern building methods the structure would be a combination of columns and steel girders, supporting the floors independently of the walls, the latter being facing work only. Eight large elevators would furnish access to the floors. Architecturally the design of Mr. PRICE is more successful and pleasing than would be expected. The general effect is that of the Campanile, in the Piazza of St. Mark, at Venice, which has served as a motive. While the building proper is steel, the exterior would be in granite, brick and terra-cotta.

THE PLANS FOR THE FORT ST. UNION DEPOT at Detroit, Mich., have been somewhat changed from the design published on page 100 of our issue of Jan. 31. The long wing is to be placed on the Fort St. side, as in Mr. GILBERT'S design, and is to contain offices on the second floor, with a large room 38 × 58 ft. at the end for the use of employees as a reading room and meeting room. The estimated cost of the structure is now set at $200,000, and the contract is to be let on Feb. 17. Mr. JAS. APPLEYARD of Lansing is to superintend the construction.

THE AMOUNT OF ALUM USED at the filter plant of the Terre Haute water-works was wrongly stated last week to be one part in 70,000 as a maximum. The mistake was due to a printer's error, the maximum amount used being one part in 7,000.

THE 24-HOUR NOTATION has been adopted on the railways of India, says *Indian Engineering*. Clocks are being supplied to the offices of the Indian State railways which show only a minute hand. The minutes appear on the circle usually occupied by the hours, and the hour appears through a slot in the dial.

PHOTOGRAPHS OF BAD ROADS are called for by Mr. ISAAC B. POTTER, chairman of the roads improvement committee of the New York League of American Wheelmen, 278 Potter Building, New York City. A reward of $100 in gold will be paid in sums of $50, $30 and $20 for series of not less than three photographs. The conditions are that such photographs must be confined to subjects that strongly illustrate the "unfitness" of present public roads, especially common dirt roads, used as public highways. Each photograph must be accompanied by a full statement of particulars, giving date, location, etc., and marked by a fictitious name for after identification. The purpose in collecting these subject lessons is a laudable one, and it is to be hoped that photographers will take sufficient interest in the matter to select from the abundance of material that unfortunately exist.

THE GATHMANN DYNAMITE GUN is to be tested by the government at Fort Sheridan, says a Chicago dispatch. This gun, the invention of Mr. LOUIS GATHMANN, is said to be capable of throwing a dynamite shell five miles from a barrel only 9½ ft. long. He uses for his impelling agent liquified carbonic acid gas, which is delivered along the whole length of the bore and also serves to keep the barrel from overheating. As far as can be learned, all experiments as yet have been confined to a small model of the gun.

THE NIAGARA POWER & DRAINAGE CO. is applying for a new charter, at Albany, to take the place of the old charter of two years ago. The time for the commencement of the work is extended to 10 years, and the capital is to be increased from $2,000,000 to $5,000,000. The original purpose of the company was to supply water and water power in the vicinity of the Niagara River. In the new bill it would be authorized to construct pipes, conduits, cables and other work all over Erie and Niagara counties, with power to run under ground about anywhere.

ALUMINUM AT $1.25 PER POUND is in the market, notwithstanding the doubt expressed, in our issue of Jan. 12, concerning a press statement to that effect. We have just seen a price list sent out to the trade by the Cowles Electric Smelting & Aluminum Co., of Lockport, N. Y., giving the following figures: In lots of more than 2,000 lbs., $1.25 per pound less 20% discount, and in 1,500 lbs., 1,000 lbs. and 500 lbs. lots, $1.25 per pound, with 15, 10 and 5% discount. In 50 to 500 lbs. the price is $1.25 net; 10 to 50 lbs. $1.50, and less than 10 lbs. $1.75, per pound.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Lake Shore & Michigan Southern.—This company will expend about $1,000,000 in improving the roadbed on its line between Buffalo, N. Y., and Chicago.

Western New York & Pennsylvania.—Engineers are now resurveying the line for the proposed extension from a point on the New Castle Division to Oil City, Pa. A. P. Bovier, Elmira, N. Y., is the engineer in charge of work.

Toronto Belt Line.—Arrangements have been completed whereby construction will soon be resumed on the belt line railway around the cities of Toronto and West Toronto. The total length of the road will be 28 miles, and of this distance 12¾ miles will be new construction. E. D. Edgar, Toronto, Ont., President.

Chicago & Eastern Illinois.—The engineers of this company have reached Campbellsburg, Ind., in their survey from Terre Haute, Ind., south to Louisville, Ky.

New York Central & Hudson River.—Chief Engineer Walter Katte and other officials of this company are inspecting the route of the Mohawk & St. Lawrence R. R. from Utica to Clayton, N. Y., preparatory to commencing work. They are reported as saying that the road will be built, and that work will begin at once.

Ft. Wayne, Terre Haute & Southwestern.—Work is making good progress on this Indiana railway. Grading is completed between Bridgeton and Mansfield, Ind., and a large part of the trestling is finished.

Chicago & West Michigan.—The report is in circulation that this company has secured the right of way of the old Detroit, Charlevoix & Escanaba R. R. between Charlevoix and Petoskey, Mich., and will begin the construction of that line during the spring.

New York, New Haven & Hartford.—This company will construct a station at New Haven, Conn., to cost $60,000, and another at the Harlem River, N. Y. The latter will be built of brick, and will be 300 ft. long.

Delaware & Hudson Canal Co.—Chappell & Burke, Rutland, Vt., Civil Engineers, write as follows:

The Ticonderoga R. R. is projected to connect the Delaware & Hudson Canal Co.'s R. R. with the pulp and paper mills of the Ticonderoga Pulp & Paper Co. and the Glens Falls Paper Co., near the village of Ticonderoga, N. Y. Its total length will be 2.55 miles, of which 0.85 miles will be side track. About 2.33 miles are now completed, and the remaining 1,700 ft. will be finished in the spring. The work was light; maximum grade 3%, and maximum curve 15°. Maurice Dower, of Ballston, N. Y., was the contractor. The road will do both a freight and passenger business.

Projects and Surveys.

State Line & Eastern.—Incorporated in Indiana to build a railway 145 miles long through the counties of Lake, Porter, La Porte, St. Joseph, La Grange and Steuben. Among the incorporators are: Geo. W. Lenn, Leroy Armstrong and Walter I. Pratt, all of Chicago.

Columbus Terminal.—Chartered in Ohio to build a terminal transfer railway in the city of Columbus. Among the incorporators are: D. N. Budd, Eugene Powell and Chas. E. Bedwell.

Ellsworth & Tremont.—Henry H. Clark and others ask an act incorporating a railway company by this name to build a line from Ellsworth to Southwest Harbor, Tremont Co., Me.

Greenland & Epping.—An effort is being made by the people along the route to secure the construction of a railway from Greenland to Epping, N. H., 13 miles. Surveys were made for the line in August, 1890, by A. W. Dudley, Exeter, N. H. It is probable that it will be operated by the Portland & Rochester R. R. when completed.

Iron Range & Huron Bay.—Milo Davis, Arvon, Baraga Co., Mich., Chief Engineer, writes as follows:

This road is projected to run from Arvon or Huron Bay, Mich., via Champion, to Republic and Michigamme, Mich., 60 miles. The line has been located from Arvon to Champion, 25 miles, and the surveys for the remaining distance will be commenced in the spring. The route is through a very rough country. Wallace Dingman, of Butte Creek, Mich., is the contractor. It is expected to commence work about May 1, and to have a portion of the line completed by Sept. 1, 1891. The capital for construction is being furnished by C. H. Buhl and Henry Stephens, and the object of the road is to open up the iron mines along the route. C. H. Buhl, of Detroit, is President.

SOUTHERN.—Existing Roads.

Knoxville, Cumberland Gap & Louisville.—It is announced that work will begin soon on the construction of an extension from Middlesborough, Ky., to Curryville, Tenn., 40miles.

Savannah, Americus & Montgomery.—Work on the bridge across the Chattahoochee River is making good progress. Between the river and Hurtsboro, Ala., about 12 miles of track have been laid and the grading nearly completed. It is expected to have the line completed to Montgomery, Ala., by July 1, 1891.

Atlantic & Danville.—Construction has commenced on the Danville & East Tennessee R. R. east from Bristol, Tenn. About 500 hands will be put at work, and it is expected to have the section from Bristol to Damascus completed by Nov. 1, 1891. T. W. M. Draper, Norfolk, Va. Chief Engineer.

Georgia Southern & Florida.—It is stated that work will not be resumed on the Macon & Birmingham R. R. until the line from Macon to Savannah, Ga., is finished. The road now terminates at La Grange, Ga., 95 miles northwest of Macon.

Piedmont, Laney & Birmingham.—Work has been commenced on a further extension of this road from the end of track to Piedmont, Ala., about 10 miles. J. C. Laney, Laney, Ala., is President.

Abingdon Coal & Iron.—Wm. Venefick has the contract for building the first 4 miles of this railway from Abingdon toward Damascus, Va. The road will be about 30 miles long when completed.

Fort Payne & Eastern.—It is announced that the capital stock of this company, amounting to $2,000,000, has been subscribed and that steps will be taken at once to extend the route to Rome, Ga., and ultimately to the Atlantic coast. It is stated that surveys will begin at once.

Projects and Surveys.

Pennsboro, Auburn & Glenville.—Mr. P. Kimball, Pennsboro, W. Va., is President of this company, whose organization was noted some time ago.

Richmond & Chesapeake.—It is announced that this company, organized some years ago to build a line of railway from Richmond, Va., to Wicomico, Va., about 50 miles, has been reorganized and that construction will be renewed. The officers of the company are: Mr. L. A. Reed, of New York City, President; C. E. Belvin, of Richmond, Vice-President, and Herman R. Baltzer, of New York, Treasurer. Bonds to the amount of $2,000,000 are to be issued, and it is said that arrangements have been made to place them with a syndicate of New York and foreign capitalists. The carrying out of the scheme involves the building of a tunnel about ¾ mile long, for entrance to Richmond, and it is believed that this will be utilized under a contract or lease by the Richmond & Petersburg and the Richmond & Fredericksburg railways, and probably also by the Norfolk & Western R. R.

Henderson State Line.—Surveys are now in progress for this line from Henderson to Bowling Green, Ky., 100 miles. S. K. Sneed, Henderson, Ky., President.

Asheville & Thermal Belt.—A bill is before the North Carolina Legislature to charter this company to build a railway from Asheville to Rutherfordton, N. C.

Asheville Southern.—Application will be made to the North Carolina Legislature for a charter to build a railway by this name.

Alabama, Florida & Chattanooga.—A bill is before the Alabama Legislature chartering a railway company by this name.

Spartanburg & Clifton.—The preliminary surveys for this South Carolina railway have been completed, and it is stated that work on construction will begin soon.

Charleston, Kentucky & Western.—H. Clay McKee, of Mt. Sterling, Ky., writes us that this road is to run from Mt. Sterling to Middlesborough, Ky., a distance of 180 miles. Surveys will begin in the spring and construction begun during the season.

NORTHWEST.—Existing Roads.

Chicago, Burlington & Northern.—It is stated that surveys are being made for a branch to Rochester, Minn.

Pacific Short Line.—It is reported that the western stockholders of this company have purchased the interest of the New York capitalists and will at once extend the line west from O'Neill, Neb.

Projects and Surveys.

Belleville & St. Louis.—Edward L. Thomas, of Belleville, Ill., writes as follows:

This road is to run from East St. Louis southeast into coal lands, a distance of 10 miles, and ultimately to Belleville, Ill., 3½ miles further. The work is light. Thomas & Boling have the contract for grading the first 10 miles, the work to be completed by April 1. Tracklaying will begin immediately after, and the road is to be completed by July 1. The President of the company is Wm. A. Adams, of St. Louis, Mo., and the Chief Engineer is Wm. A. Reis, St. Louis, Mo.

Muscatine, Rock Island & Peoria.—Chartered in Illinois to build a line of railway from Muscatine to Peoria.

Ill. Among the incorporators are: Andrew Henry, Peoria, Ill.; S. J. Hodge and Geo. Hodge, Wenona, Ill. The principal offices will be at Peoria, Ill.

Fremont & Yankton.—At the annual meeting of the directors recently held the following officers were elected: President, J. U. Love; Secretary, C. Christensen, and Treasurer, W. R. Wilson. It was decided to begin the surveys for the line, which is projected to run from Fremont, Neb., to Yankton, S. Dak., about March 15. The general offices will be at Fremont.

Duluth, Red Lake Falls & Northern.—The surveys for this line from Red Luke Falls, Minn., east toward Duluth, Minn., have reached a point near Grand Rapids, Minn., on the Mississippi River. A very favorable route is reported to have been secured. The engineers are now at work from the river east to Duluth. E. T. Abbott, of Minneapolis, Minn., is Chief Engineer.

SOUTHWEST.—Existing Roads.

Choctaw Coal & Railway Co.—It is stated that the financial troubles of this company have been practically settled and that construction will be resumed at once. The line between McAlister and Reno City, Ind. Ter., will be completed first.

Little Rock & Memphis.—The Memphis, Little Rock & Pacific R. R. Co. has been chartered to build an extension of this road from Argenta, near Little Rock, Ark., to the Indian Territory line, a distance of about 150 miles. The scheme includes the construction of a $300,000 bridge across the Arkansas River at Little Rock. Among the incorporators are: J. M. Rose, Little Rock, Ark.; D. C. Rugg, Hot Springs, Ark., and H. L. Schwanecke, Little Rock.

Projects and Surveys.

Houston Belt.—At a meeting of the directors recently held it was decided to commence the construction of this 15-mile belt transfer at Houston, Tex., at once. The line will encircle the city, connecting with all the railway lines converging at that point. Its principal business will be the transfer of freight, but it will also do a passenger business.

ROCKY MT. AND PACIFIC.—Existing Roads.

Canadian Pacific.—The 3,000-ft. bridge across the Fraser River, on the Missouri Branch, has been completed. Tracklaying will begin at once on the section south of the river, and it is expected to have the whole line completed in two months.

Union Pacific.—New steel rails are being laid on the branch from Nampa to Boisé City, Idaho.

Northern Pacific.—Grading on the line from Acosta, Wash., has been completed, and work is now in progress on the bridges. No tracklaying can be done for some time on account of the weather.

Satsop.—This company and the Seattle Lumber Co. will be consolidated under the name of the Washington Southern Ry. Co. The road is now 14 miles long, and does a lumber business only. It is the intention of the new company to extend the line to Port Angeles, Wash., and to the Pacific coast. J. R. McDonald, Seattle, Wash., President.

Projects and Surveys.

Denver, Apex & Western.—Chartered in Colorado to build a railway from Denver to Lookout Mt. It is expected to have the road in operation by June 1 next. The gentlemen backing the scheme are ex-Senator H. W. A. Tabor, ex-Lieut. Gov. W. G. Smith and William C. Miller. Entrance to the city of Denver will be secured by an arrangement with the Denver & Rio Grande R. R. Co.

Tintic.—This company, noted last week, has completed its organization by electing the following officers: President, Geo. A. Rice; First Vice President, A. E. Hyde; Second Vice-President, W. W. Chisholm; Secretary, J. A. Cunningham, and Treasurer, L. A. Bailey. The line is to run from Provo or Springville, Utah, southwest to Tintic, Utah, a distance of about 50 miles. The estimated cost is about $1,000,000. This includes construction, equipment, depots, and everything complete. The rails are to be 56-lb. steel, with 3,000 ties to the mile. The grade does not exceed 1% for 30 miles, 3% for the following 7 miles, and 2% for the last 13 miles. The maximum curvature will be 10°, there being no curves to speak of outside of the 7 miles south from Goshen. The equipment is to be first-class in every respect, but chiefly freight, as the main object of the road is to handle all the ores from the mines along the route, as well as from numerous other points, to be reached eventually by branches. Work begins as soon as the frost is out of the ground, and the road is to be ready for operation by Aug. 1.

CITY TRANSIT.

Electrical Railways.—New lines or extensions are reported as probable in the following cities: Newton, Mass., address the Street Railway Co.; Olympia, Wash.; Clayton, Mo., address the Lindell Electrical Ry. Co., St. Louis, Mo.; Atlanta, Ga., address the Capital Ry. and the Atlanta Street Ry.

Calais, Me.—A bill has been introduced in the State Legislature by Representative Newton to incorporate the Calais Electric R. R. with a capital stock of $100,000.

Derry Depot, N. H.—A charter for an electric line to Chester is now before the Legislature and will probably be passed, it is said.

Fall River, Mass.—A local newspaper reports that there is no doubt of the construction of an electric freight and passenger railway in this city. A bill granting a franchise has already passed the House and is now before the Senate. The proposed location is almost entirely on private property, the owners of which have thus far been favorable to the scheme.

Bridgeport, Conn.—The Bridgeport Horse Ry. will be changed to an electric line in accordance with plans and specifications prepared by the Thomas Murray Co., 95 Liberty St., New York. The same company also has a contract for a 16-mile electric line at Long Branch, N. J.

Jamestown, N. Y.—The Common Council has given the franchise of certain streets to the Jamestown Street Ry., and also given the same company permission to change its present lines from a horse to an electric railway. In return for this, the city will receive 3% of the gross receipts of the company.

Lockport, N. Y.—An electric railway from Rochester to Niagara Falls is reported to be under discussion. James McCollum, of Newfane, can give further information.

Irvington, N. J.—The Electric Lighting Co. has received a 5 year contract to light the village with 16 c. p. lamps at $16.66 per lamp annually.

Trenton, N. J.—It is reported that Philadelphia parties have bought right of way for an electric road between Salem and Quinton.

Scottdale, Pa.—An electric railway is projected from Dawson to Juniata, a new coke town, near Connellsville. Col. A. J Hill, of Dawson, is interested in the project.

Danville, Va.—The entire plant of the Danville Electric Street Car Co. was burned Feb. 6; the loss is between $15,000 and $20,000.

Memphis, Tenn.—It is reported that the East End Ry is contemplating the construction of an electric plant, and that a new company is being formed to build several lines through Chelsea.

Lexington, Ky.—The Passenger & Belt Ry. will build 2 miles of additional track.

Terre Haute, Ind.—The Terre Haute Street Ry. has purchased the Vigo Street Ry. and will soon begin to extend and improve the track of the purchased lines preparatory to introducing electric cars.

Brazil, Ind.—Terre Haute parties are said to have obtained franchises for the construction of an electric line from this town to Harmony.

Chicago, Ill.—The 95th street electric railway will, it is said, be built mainly by the property owners along the proposed route, who are to pay a bonus of $10,000 per mile.

Seattle, Wash.—An electric railway route has been surveyed from this city to Brooklyn, and some of the contracts for its construction have been let. D. T. Denny can give further information.

Dummy Railways.—*Cartersville, Ga.*—A dummy line to Emerson will probably be built.

Renfroe, Ala.—The Renfroe Street Ry. has organized with W. A. Jubinger President, to build a dummy line.

Horse Railways.—*Lewiston, Me.*—The Lewiston & Auburn Horse Ry. will, it is said, manufacture their own cars and also supply outside orders.

La Grange, Ga.—F. M. Longley, F. M. Redley, J. P. Thornton and G. E. Dallis have applied to the City Council for a street railway franchise.

Cincinnati, O.—G. R. Werner, E. Locke and F. W. Freeman have applied for a franchise to construct and operate a double track railway on a number of streets.

Seymour, Ind.—The Council has granted a franchise to B. F. Price for a railway on a number of streets. The entire line will, it is said, be completed within six months.

Port Huron, Mich.—The Chestnut & Griswold Street Ry. have received a franchise for an electric or horse railway.

New Companies.—Adams' Electric Ry., East St. Louis, Ill.; capital stock, $5,000,000; incorporators, E. V. Rings, A. E. McRee, E. A. Engler. East Cleveland, Euclid & Wickliffe Street R. R., Euclid, O.; capital stock, $15,000; incorporators, R. A. Hunt, H. Avery, F. B. Tracy and others. Valley Street Ry., Seattle, Wash.; capital stock, $125,000; incorporators, J. Horton, J. Lines, J. A. Gould and others. New York & Suburban R. R.; capital stock, $500,000; incorporators, C. Hadden, A. W. Dieter, A. J. Willets, W. H. Duryea, of Brooklyn.

HIGHWAYS.

Massachusetts.—Two roads will be built in South Framingham. There will be two bridges over the Boston & Albany R. R. Plans and specifications for the roads are on file at the office of the county engineer. Proposals will be received until March 3 by the County Commissioners of Middlesex Co., Court House, East Cambridge.

Texas.—The House Committee on County Roads and Bridges are formulating a scheme for working the county roads. Their plan is one they think superior to the Potter bill in the Senate. They have divided the subject into three parts: 1st, the method; 2d, the men who are to do the work, and 3d, the revenue necessary. Bills covering each of these subjects will be framed by the committee. The bill for the first branch has been printed, and provides for a county road superintendent and one assistant superintendent for each commissioner's precinct. The salary of the superintendent is not to exceed $100 a month, and his term of office 12 months. He is to give bond for $5,000, with 3 good sureties, for faithful performance of duty. The assistant superintendent for each commissioner's precinct to receive not more than $2 per day. The superintendent to have control of all tools, implements, teams, etc., and to direct the work of all assistant superintendents, overseers, employees, hands and convicts, and to superintend all work of grading, draining or laying out of roads, purchasing material and building bridges. He shall have his office in that of the county judge, where a book shall be kept with separate accounts of the different road and bridge funds. He shall, as nearly as possible, spend in each precinct the money collected there for road building and repairing. He shall make regular reports of all work done to the county commissioners' court at its regular term, or whenever called on by the county judge to do so, and all his vouchers shall be approved by that functionary before the same are paid by the county treasurer.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Ottawa, Ont.*—At a meeting of the stockholders of the Interprovincial Bridge Co., held recently, it was decided to open books for subscriptions to stock at once. Efforts will also be made to secure bonuses from the Dominion and Provincial Governments and from the various railway companies. The company was organized about one year ago.

Littleton, N. H.—The citizens will vote soon on the proposition to build a bridge across the Connecticut River at this point.

Baltimore, Md.—Plans have been prepared for an iron bridge on North Ave., to cost $388,000. The bridge will be built jointly by the city and the Baltimore Belt R. R. Co.

Indianapolis, Ind.—Several plans have been prepared for the proposed Virginia Ave. viaduct.

Winston, N. C.—The Winston-Salem Land & Improvement Co. will construct an iron bridge at this place.

Leathers Ford, Ga.—A bridge over the Chestatee River at this point is talked of. F. M. Williams, Dahlonega, Ga.

Atlanta, Ga.—The City Council has appropriated $25,000 toward the construction of the Forsyth St. bridge.

Ocean Springs, Miss.—A bridge will be built across Fort Bayou near this point.

Caldwell Co., Tex.—Five iron bridges will be built by this county.

Sellwood, Ore.—The Sellwood Bridge Co., of Portland, Ore., has been incorporated. The object is to construct and operate a toll bridge across the Willamette River at Sellwood; $100,000 is the value of the capital stock. E. B. Williams, M. A. Hackett and A. W. Lambert are the incorporators.

WATER-WORKS.

NEW ENGLAND.

Lamoine Beach, Me.—The Blunt's Pond Water Co. has applied for a charter allowing it to construct works.

Turner's Falls, Mass.—The pumping station at Lake Pleasant was burned Feb. 7.

MIDDLE.

Albany, N. Y.—The prevalence of typhoid fever is attributed to the quality of the Hudson River water supply.

Auburn, N. Y.—A bill authorizing the construction or purchase of works by the city is before the Legislature. The present works are owned by the Auburn Water-Works Co., and give excellent service, but it is claimed that the rates are too high, and that municipal ownership is preferable.

Newark, N. J.—A 24-in. supply main from the low-service reservoir to connect with the distribution is projected.

Vineland, N. J.—The Vineland Water-Works Co. has been incorported; capital stock, $75,000. Works were built here in 1886 by Charles J. Keighley.

Lebanon, Pa.—W. T. Burnside, City Engineer, has sent the following:

Bids will be received in gross for the construction of a 35,000,000-gall. storage reservoir and appurtenances. The dam will have a length of 280 ft., and extreme height of 42 ft., inner slopes of 3, and outer of 2 to 1. The water surface will be 4½ acres. There will be a 16-in. drain and a 12-in. effluent pipe.

Millvale, Pa.—F. Klussman, President, informs us that the Bennett Water-Works Co. put works in operation Jan. 26. Water is pumped to a tank and there are about 5 miles of mains.

Elkton, Md.—Address G. A. Blake regarding proposed works.

SOUTHERN.

Berryville, Va.—The bids previously invited and received have all been rejected by the Berryville Water Co., and new bids for complete works will be received until March 2. T. S. Thompson is Secretary.

Bluefield, W. Va.—The Bluefield Water-Works and Investment Co. propose to complete the water-works.

Columbia, S. C.—Bids are wanted by the city until March 2 for a 3,000,000-gall. water-power pump, with wheels and appurtenances, and a 20 × 75-ft. stand-pipe. Address W. J. Cathcart, City Clerk.

Washington, Ga.—It is reported that works are to be built by M. P. Carroll, E. J. O'Connor, of Augusta, and others.

Clarksdale, Miss.—Works are projected.

Grenada, Miss.—Address Alexander Allison or the Mayor regarding proposed works.

Cleveland, Tenn.—Ingersoll & Peyton, Attorneys, Knoxville, inform us that George W. Sturtevant and W. H. Whitcome will build works to cost about $50,000, having contracted with the city to that effect.

Dayton, Tenn.—Works are projected.

Greenville, Tenn—Address J. B. Spencer regarding projected works.

Union City, Tenn.—Application for the incorporation of the Union City Water Co. has been made.

NORTH CENTRAL.

Cincinnati, O.—Superintendent Thorp has recommended the awarding of a contract for two 6,000,000-gall. pumps to the Holly Manufacturing Co. for $53,000.

Niles, O.—J. B. Strawn has been making surveys and estimates for works for the city.

Angola, Ind.—W. M. Carr, City Clerk, informs us that they expect to have works this coming season.

Chicago, Ill.—A. W. Cooke, City Engineer, informs us that specifications are being prepared for two new horizontal compound condensing engines with a capacity of 12,000,000 galls. each, to be placed at the Hyde Park pumping station.

Du Quoin, Ill.—J. R. Truesdale has sent the following: Six 6-in. Cook wells, with a combined daily capacity of 650,000 galls., have been sunk. A company will be organized in a few days, and it is expected that works will be completed by June 1. A 1,000,000-gall. pump will lift water to a 12½ × 125-ft. stand-pipe. There will be six miles of cast-iron mains and 50 hydrants. The estimated cost is $75,000. Population, 5,000. The works will be built by the company.

Quincy, Ill.—Plans for new works, to be owned by the city, have been accepted by Council, and the committee appointed to confer with the owners of the present plant have reported unanimously in favor of the plans. Messrs. McRitchie & Nichol, Chicago, are the Engineers. G. H Walker, J. H. Fischer and Samuel Harrop constitute the committee. The works are estimated to cost $620,000.

Wheaton, Ill.—The Wheaton Electric Light & Water Co. has been incorporated; capital stock, $20,000.

NORTHWESTERN.

Glenwood, Ia.—The following is from Seth Dean, Engineer:

The artesian well is completed, having reached a depth of 2,000 ft. There is an abundant supply but no flow. Water-works will be put in this spring.

Orange Grove, Ia.—Contracts for a well have been let.

Perry, Ia.—The following is from S. M. Thornley, Mayor:

The city contemplates granting a franchise for works, and will rent 21 hydrants at $75 per year on the start. Fuel is cheap and flowing artesian water can be secured at a depth of 100 to 110 ft.

Hay Springs, Neb.—Madison Finch informs us that bonds for works have been voted.

Springfield, S. Dak.—A. T. Bridgeman, City Clerk, informs us that about 1,800 ft. of 4, 5 or 6-in. pipe will be laid from the new well this season.

Helena, Mont.—Additional works have been completed by the Helena Consolidated Water Co., which will give the city a full gravity supply.

SOUTHWESTERN.

Mound City, Mo.—W. Kiersted, Kansas City, informs us that the works were accepted by the city Feb. 2. Water is pumped from 4 6-in. Cook wells, 88 ft. deep, to a stand-pipe. There are about two miles of pipe and 16 hydrants. Population about 2,000.

Morrillton, Ark.—W. E. De Long, Dardanelle, informs us that he has a franchise for works here.

Cleburne, Tex.—The Cleburne Ice, Light & Water Co. has been incorporated; capital stock, $50,000. Works were built here in 1883-4 by the town.

Waco, Tex.—The Waco Water-Works & Light Co. has been incorporated; capital stock, $500,000. The Waco Water & Power Co. and the Bell Water Co. both have works in operation here. The new company may be a reorganization of one of the old.

PACIFIC.

Los Gatos, Cal.—The following is from T. G. Murphy, President, San Francisco:

The Cold Spring Water Co. proposes to let contracts for works about March 1; estimated cost, $25,000 to $30,000. The supply will be by gravity from a reservoir on a mountain stream. S. W. Smith is Secretary. Population, 1,500.

Monrovia, Cal.—C. O. Monroe informs us that the amount to be expended by the city for additional supply, including pipe and reservoir, is $40,000.

Oakland, Cal.—A 4,000,000-gall. Hyatt filtering plant is nearing completion, and will be in operation about April 1.

Salt Lake City, Utah.—Superintendent W. H. Ryan recommends in his annual report, as published in the *Tribune* of that city, the cementing of the reservoir at First South and Thirteenth East Sts.; the construction of a 1,500,000 gall. reservoir on City Creek; the laying of a supply main for irrigation purposes, and the continuation of the development and improvement of the supply from City Creek and the adjacent springs. The City Engineer and some of the Council favor the introduction of a supply from Parley's Cañon. The *Tribune* opposes the latter, on the ground that a more available supply can be obtained by pumping water, in the dry season, running to waste at above Liberty Park.

ARTESIAN WELLS.

Lambert's Point, Va.—A well will be sunk by the Norfolk & Western R. R. Co., whose offices are at Roanoke.

Mason City, Ia.—It is reported that the well is down 1,390, with no water, and that the hole will be abandoned.

Utah.—A company with a capital stock of $15,000 is projected to sink wells at Huntington, Castle Dale, Orangeville, Ferren and Price.

IRRIGATION.

Waco, Tex.—The Waco Water & Power Co. proposes to construct storage reservoirs and furnish water for irrigation and power.

Casper, Wyo.—A. T. Butler, Town Attorney, informs us that the town proposes to put in a surface system of water-works, and wishes to correspond with contractors who make a specialty of irrigation works where water has to be pumped.

Colorado.—The following irrigation companies are reported by the Chicago *National Corporation Reporter* as recently incorporated, the figures representing capital stock: San Luis Land, Reservoir & Irrigation Co., Alamosa, $100,000; New South Boulder Canon Ditch Co., Boulder, $30,500; Boston Farm Canal Co., Ordway, $25,000; High Line Reservoir Co., Denver, $150,000; Blue Stone Valley Ditch Co., De Beque, to operate in Garfield and Mesa counties, $50,000; Banner Ditch & Reservoir Co., Hudson, $60,000.

SEWERAGE AND MUNICIPAL.

Sewers.—***Hyde Park, Mass.***—The question of providing for a system of sewerage is under consideration.

Memphis, Tenn.—Col. Waring has been appointed Consulting Engineer to the Sewerage Department. His system was first introduced in 1880. Since then it has been and is still being extended.

Jacksonville, Fla.—The city engineer has been authorized to purchase a 4-in. centrifugal pump for the receiving basin for the disposal of the sewage of the Springfield suburb.

Cleveland, O.—Plans for work to be done during the coming season have been prepared by Mr. Force, City Engineer. About 25 miles of sewers will be built, including the large one on Walworth St. In 1889, 10 miles were built, and 17 miles in 1890.

Terre Haute, Ind.—One district in the business portion of the city, which has now surface drainage, will have sewers built this year at a cost of $15,000 to $25,000. To complete the sewerage system would require the construction of about 4 miles of main sewer and 4 miles of laterals. The main sewer would cost about $200,000.

Oak Park, Ill.—The ordinances for streets, sewers and improvements will appropriate about $1,250,000.

Streets.—***Buffalo, N. Y.***—The Street Committee has awarded the contract for paving Clinton Ave. to the Barber Asphalt Paving Co. at $76,000.

Cumberland, Ind.—The property owners on Center St. will pay $1.25 per lin. ft. for their share for the cost of brick paving.

Berkeley, Va.—It is proposed to issue $10,000 in bonds for street improvements.

Bluefield, W. Va.—The Bluefield Improvement Co. proposes to carry out extensive street improvements.

Covington, Ky.—An ordinance has been passed providing for asphalt paving on Madison ave.

Atlanta, Ga.—Ordinances have been passed for Belgian block paving on Peachtree, Linden and Houston Sts. and Forest Ave., at a total cost of about $31,550. Venable Bros. have submitted a proposition for granite paving and curbing the city for 5 years.

Montgomery, Ala.—The city engineer has been directed to prepare specifications for Belgian block paving on Commerce St. and Court Sq., and the Street Committee will advertise for bids for the paving.

Avondale, O.—The Village Council is discussing the merits of brick and asphalt paving for Main Ave.

Cleveland, O.—The city engineer, Mr. Force, is preparing plans for street work in the spring, which will be more extensive than for 1890. He is opposed to brick paving on down-town streets.

Detroit, Mich.—The Board of Estimates will conclude its work by April 15, so that the street paving contracts will be let before May.

Lighting.—***Memphis, Tenn.***—The Peoples Fuel & Gaslight Co. has been organized by Allan Asher, M. Hardwig, J. A. Taylor, J. M. Goodbar and others, to operate the Fahnehjelm fuel gas process and incandescent burner. The plant will have a capacity of 1,000,000 to 1,250,000 cu. ft. per day, and will cost about $300,000.

Columbus, O.—The following proposals have been received by the Board of Public Works for naphtha, gasoline, petroleum or other lamps of not less than 16 c. p.: Sun Vapor Street Light Co., $13.55 for moonlight schedule, $16 for all night; Jones & Underhill, $13.95, $16.85; Globe Light & Heat Co., $15.50, $18; Western Street Light Co., $15.40, $17.50; Columbus Gas Light & Coke Co., $16.25, $19.25.

Refrigerating Conduits.—***Brooklyn, N. Y.***—The Economy Refrigerating Co. has applied for permission to lay pipes or conduits for furnishing ammonia gas for refrigerating purposes from a central station to houses, stores, etc.

ELECTRICAL.

Electric Light.—New plants or extensions of existing systems are reported as probable in the following places: Newport, R. I.; Peabody, Mass., address the Town Clerk; Woodsville, N. H.; Germantown, Pa., address the Germantown Electric Light Co.; Mahanoy City, Pa., address the Electric Light Co.; Nauvoo, Ia.; Redlands, Cal.; Charlottesville, Va., address the Jefferson Park Hotel & Land Co.; Maysville, Ky., address the Mayaville Gas Light Co.; Woodberry, Md., address the Woodberry Electric Light Co.; Clarksdale, Miss., address the Mayor; Salisbury, N. C., address the Salisbury Gas & Electric Co.; Martinsville, Va.; Elmhurst, Ill.; Wilkinsburg, Pa., address the Wilkinsburg Electric Co.

Beverly, Mass.—The Committee on Lighting will open bids Feb. 25 for lighting the town with electric lamps on 5 or 10-year contracts. Address R. W. Boyden, 87 Milk St., Boston.

Lockport, N. Y.—The city wants bids for electric lighting for 3 years, beginning April next. At present Lockport is lighted by the Brush system, in the hands of the Gas Co., at $80 per night.

Walton, N. Y.—It is reported that $15,000 have been subscribed by the residents here for the purpose of establishing an electric plant.

Shenango Valley, Pa.—It is reported that the Shenango Valley Electric Light Co. will put in a $40,000 plant. Enoch Filer is President and W. G. Filer, Secretary, both of Sharon.

Homestead, Pa.—The Homestead Electric Light & Power Co., J. Most, Secretary, will, it is said, erect a plant for 1,500 incandescent and 100 arc lamps.

Wheeling, W. Va.—The West Virginia House of Delegates has passed a bill permitting the city of Wheeling to manufacture and sell electricity to private consumers.

Clifton Forge, Va.—The Clifton Forge Electric Light & Power Co. will soon purchase a plant.

Bentonville, Va.—The Bentonville Mining & Improvement Co. will, it is reported, erect an electric light plant and construct water-works at this place. F. H. Bolen is General Manager of the company.

Attalla, Ala.—The city will issue $50,000 of bonds for the construction of water-works and an electric plant, concerning which the Mayor will give further information.

Union City, Tenn.—The Union City Water Co. proposes to erect an electric plant and construct water-works. Price Thomas is the manager of the company.

Jackson, Tenn.—The city will issue $50,000 of bonds, $20,000 to be used for the purchase of an electric light plant.

Columbus, O.—The following bids for furnishing 800 lights of 2,000 c. p. were recently opened: Electric Illuminating Co., Chicago; all dark hours, $70; moonlight schedule, $70; all night, $80. Columbus Electric Light & Power Co; all dark hours, $87.50; moonlight schedule, $75; all night, $100.

Crawfordsville, Ind.—The City Council will, it is said, establish an electric plant at a cost not exceeding $25,000.

Chillicothe, Mo.—A. F. Benson, Batesville, Ark., has a 5-year contract for supplying this village with 30 arc lamps of 2,000 c. p. Supplies are wanted.

Creston, Ia.—A. H. Spurr has received franchises for electric light and electric street railway plants.

Audubon, Ia.—The town has voted to establish an electric lighting plant.

Highlands, Col.—A company in which F. P. Arbuckle is a leading member has offered to light the village with arc lamps at $11 per month, $1.50 less than the present rate.

New Companies.—Day Electrical Construction Co., Chicago, Ill.; capital stock, $1,000,000; incorporators, L. D. Condee, H. F. Billings and G. B. Lathrop. Universal Motor Co., East St. Louis, Ill.; capital stock, $2,000,000; incorporators, J. Kehl, A. S. Mann, J. Tremlett. Chicago, Ill., Electric Motor Co.; capital stock, $250,000; incorporators, B. D. Southard, J. H. Dean, E. A. Manship. Union Electric Mfg. Co., Bridgeport, Conn.; incorporators, J. M. Orford, J. English, M. T. Clark, Baltimore, Md., Electric Refining Co.; capital stock, $500,000; incorporators, C. F. Meyer, Ward S. Koyser, of New York. Carpenter Electric Co., Chicago, Ill.; capital stock, $10,000,000; incorporators, H. H. Carpenter, H. F. Kent, S. D. King. Twin City Electric Street Ry. Light & Power Co., Dennison and Uhrichsville, O.; capital stock, $25,000. Montrose Electric Co., Chicago, Ill.; capital stock, $100,000; incorporators, A. H. Floaten, F. M. Longfellow, A. A. Adair and others.

CONTRACTING.

City Work.—***Amsterdam, N. Y.***—The contract price for asphalt paving was $2.90 per sq. yd., and not $2.80 as given on p. 144.

Detroit, Mich.—The lowest bids received by the Board of Public Works for furnishing supplies were as follows: Cement, A. D. Noble, 87 cts. per bbl.; stone for receiving basins, Ortman & Groat, $26.45; plank crosswalks, 29½ cts. per lin. ft., and 1½ cts. extra for scantling; sewer grate castings and drinking fountains for horses, Griffin Car Wheel Co., $1.90 per 100 lbs. for castings, and $90 each for

fountains; McKinstry Ave. sewer, Langley & Jeynes, $5.47 per lin. ft. and $25 for manholes.

Breakwater.—*Port Jefferson, N. Y.*—The contract has been awarded to Humphrey Toomey, of Southport, Conn., at $1.50.

Dredging.—*Norfolk, Va.*—The following proposals for dredging in the harbor have been received by Lieut. J. G. Febiger, U. S. Engineer Office: Morris & Cummings Dredging Co., New York, 10.3 cts. per cu. yd.; National Dredging Co., Wilmington, Del., 10.7 cts.; Atlas Dredging Co., Wilmington, Del., 10.7 cts.; P. Sanford Ross, Jersey City, N. J., 10.9 cts.; Baltimore Dredging Co., Baltimore-Md., 12⅝ cts.

Piles.—*New York, N. Y.*—The Docks Department has awarded a contract to Beard & Kempland at $9, $10 and $10.50 each for piles 55 to 60 ft., 60 to 65 ft. and 65 to 70 ft. long respectively.

Removing Ledge, Dredging, Etc.—The following proposals were received Feb. 10 by Lieut.-Col. J. A. Smith, U. S. Engineer Office, Portland, Me.: Removing ledge in York Harbor, Me.; Thos. Symonds, Leominster, Mass., $13 per cu. yd. in scows; Geo. W. Townsend, Boston, Mass., $14.49; S. S. Andrews, Gorham, Me., and H. H. Sturgis' Bonny Eagle, Me., $23. Removing ledge in Portsmouth Harbor, N. H.: Thos. Symonds, $13 per cu. yd., in situ; Geo. W. Townsend, $16.97; S. S. Andrews and H. H. Sturgis, $17 45; E. H. French, Fulton, N. Y., $21. Dredging in Portland Harbor, Me.: Edward Moore and A. R. Wright, Portland, 19 and 9½ cts. per cu. yd. in situ for hard and soft material; A. K. Stone, Roxbury, Mass., 25 and 15 cts.; National Dredging Co., Wilmington, Del., 26 and 13 cts. Dredging in Back Bay, Portland harbor, Me.; National Dredging Co., 11 cts. per cu. yd. in scows; Moore & Wright, Portland, 11½ cts.; C. H. Souther, Boston, Mass., 20 cts.; Hamilton & Sawyer, Portland, 20½ cts.; A. K. Stone, 21 cts. Breakwater and beacon at Moose-a-bec bar, Me.; J. F. Hamilton and I. F. Webber, Portland; $2,670 for constructing breakwater complete, 97 cts. per ton for stone delivered in breakwater.

Settling Basins.—*St. Louis, Mo.*—The following table gives the prices of bids received by the Board of Public Improvements for the construction of four settling basins 670 ft. by 400 ft. at the Chain of Rocks. The bidders are as follows: A, Smith & Minahan; B, Scott, Lantry & Sons; C, T. J. Prosser & Co.; D, Laine & Mulcahy; E, Heman Construction Co.; F, McCormick Construction Co.; G, Black & Davies; H, Wm. McCully; I, Allen & Vieths; J, Fruin-Bambrick Construction Co.; K, John Hill; L, Engineer's estimate:

	Quantities.	A.		B.		C.		D.		E.		F.		G.		H.		I.		J.		K.		L.	
		Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.
		$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$
Earth excavation	213,000 cu. yds.	.25¾	54,817	.24	51,120	.32	68,160	.30	63,900	.20	42,600	.18	38,340	.30	63,900	.25	53,250	.25	53,250	.28	59,640	.35	74,550	.27	57,510
Borrowed earth	15,500 cu. yds.	.47	7,285	.30	4,650	.40	6,200	.43	6,665	.30	4,650	.18	2,790	.40	6,200	.30	4,650	.40	6,200	.35	5,425	.35	5,425	.36	5,580
Puddle	74,000 cu. yds.	1.23	91,020	1.25	92,500	1.10	81,400	1.00	74,000	.90	66,600	1.00	74,000	.85	62,900	1.00	74,000	.90	66,600	.80	59,200	1.00	74,000	.90	66,600
Concrete	37,000 cu. yds.	5.73	212,010	6.20	229,400	6.50	240,500	7.00	259,000	6.00	222,000	5.50	203,500	6 00	222,000	6.00	222,000	5 80	214,600	5 80	214,600	6.00	222,000	6.30	233,100
Brick masonry	4,700 cu. yds.	9.20	43,240	9.75	45,825	8.50	39,950	9.78	45,966	9.00	42,300	9.00	42,300	9.40	44,180	8.50	39,950	8.25	38,775	9.00	42,300	8.00	37,600	7.65	35,955
Granitoid	67,600 sq. ft	.22	14,872	.18	12,168	.20	13,520	.20	13,520	.15	10,140	.17	11,492	.20	13,520	.20	13,520	.19	12,844	.20	13,520	.25	16,900	.18	12,168
Stone masonry, class X	315 cu. yds.	26.00	8 190	27.00	8,505	40.00	12,600	35.00	11,025	45.00	14,175	30.00	9 450	45.00	14,175	35 00	11,025	45.00	14,175	45.00	14,175	45.00	14,175	31.50	9,922
Stone masonry, class Y	970 cu. yds.	17.49	16,878	17.00	16,490	25.00	24,250	30.00	29,100	30.00	29,100	15 00	14,550	23.00	22,310	30.00	29,100	27.50	26,675	22.00	21,340	18.00	17,460	18.00	17,460
Stone masonry, class K	26,030 cu. yds.	8.49	220,740	10.20	265,200	9.75	253,500	10 75	279,500	7.50	195,000	10.00	260,000	9.40	244,400	9 50	247,000	8.90	231,400	9.00	234,000	9.00	234,000	9.00	234,000
Stone coping, 12 ins. thick	36,700 sq. ft	.97	35,599	.95	34,865	1.00	36,700	1.00	36,700	1.00	36,700	1.00	36,700	.90	33,030	.90	33,030	.95	34,865	.90	33,030	1.00	36,700	.90	33,030
Stone paving, 12 ins. thick	800 sq. ft	1.00	800	.25	200	.50	400	1.00	800	.50	400	.30	240	.30	240	1 00	800	.25	200	.30	240	.25	200	.27	216
60-in. iron pipe	440 lin. ft	29.60	13,024	15.00	6,600	30.00	13,200	30.50	13,420	35.00	15,400	25.00	11,000	30.00	13,200	30.00	13,200	25.00	11,000	33.00	14,520	30.00	13,200	30.00	13,200
24 in. iron pipe	583 lin. ft	5.70	3,306	4.00	2,320	5.00	2,900	4.00	2,320	8.00	4,640	4.00	2,320	7.00	4,060	6.00	3,483	5.00	2,900	7.00	4,060	5.00	2,900	5.00	2,900
24-in. clay pipe	3,200 lin. ft	1.87	5,984	2.50	8,000	2.00	6,400	2.00	6,400	2.00	6,400	1.00	3,200	3.00	9,600	1.50	4,800	2.20	7,040	2.50	8,000	1.50	4,800	2.06	6,400
			727,795		777,843		799,680		842,316		690,105		709,882		753,715		749,805		720,524		724,050		753,910		728,041

MANUFACTURING AND TECHNICAL.

Locomotives.—The Baldwin Locomotive Works, of Philadelphia, Pa., are building 30 engines for the Manhattan elevated road and 13 engines for Brazil. H. K. Porter & Co., of Pittsburg, Pa., have built two Forney engines for the U. S. Government; they are to be used for towing barges through the Muscle Shoals canal, in Alabama. The Brooks Locomotive Works, of Dunkirk, N. Y., are building for the Cleveland & Canton the seven engines mentioned last week on p. 144; they are also building 25 engines for the Lake Shore & Michigan Southern. The Pennsylvania Co. will add 29 locomotives of class "R" to the equipment of the southwestern system. The Alabama Locomotive Co. is to be incorporated at Montgomery, Ala., with a capital stock of $1,000,000.

Cars.—The Pullman Palace Car Co., of Chicago, Ill., has built 2 vestibuled compartment sleeping-cars for the Chicago & Alton; they are 70 ft. long, mounted on six-wheeled trucks with 38-in. wheels, and weigh 100,000 lbs.; they are fitted with Allen wheels, Blackstone platforms and couplers, Westinghouse brakes and pneumatic signals. The Pullman shops at St. Louis, Mo., were burned Feb. 5. The Wason Car Co., of Springfield, Mass., is building 50 cars for the Manhattan elevated road, 22 for the Old Colony, and 20 for the New York, New Haven & Hartford. The Ohio Falls Car Co., of Jeffersonville, Ind., is building sleeping-cars. The Peninsular Car Co., of Detroit, Mich., is building 205 freight cars for the Chicago, Burlington & Quincy. The Haskell & Barker Car Co., of Chicago, Ill., is building 100 furniture cars for the Great Northern Ry.; they are 30 ft. 6 in. long, 8 ft. 6 in. wide and 8 ft. 2 in. high. The Hogan Refrigerator Car Co., of Chicago, Ill., has been incorporated by E. J. Johnson, H. P. Pearsons and A. Woodward. It is reported that orders for 80 vestibule cars have been placed in this country by 4 English and 3 French railways.

Pintsch Gas Plant.—The Safety Car Heating & Lighting Co., of New York, will erect a Pintsch compressed gas plant at Savannah, Ga., to supply the cars of railways centering there. The plant will cost about $20,000 and will have a capacity to supply about 500 cars per day.

Car Heating.—The fire proof heater and automatic temperature regulator of the Consolidated Car Heating Co. are in use by the Wagner Palace Car Co., and the Boston & Maine, the Buffalo, Rochester & Pittsburg, and other railways.

Building.—It is proposed to erect a new court house in St. Clair County, Mich., at an estimated cost of $100,000.

The Atlas Iron Construction Co. has been organized for a general engineering and contracting business, with R. R. passenger station at Long Island City. Bridges are to be erected at Valley Falls and Mohawk, N. Y., Steep Falls, Me.: Hancock, Md., and Goshen, Va.

Wrecking Plant.—The Industrial Works, of Bay City, Mich., have built for the Union Pacific Ry. a steel car mounted with two 15 ton cranes for wrecking and construction work. They are also building for the Philadelphia & Reading R. R. a steel car 48 ft. long, upon each end of which is mounted a 20-ton steam crane and boiler; this is for wrecking and other purposes, and is said to be one of the most powerful machines of its kind ever built.

New Companies.—Gas Engineering Co., of Newark, N. J.; to build gas and water-works; incorporators, Hawley Pittbone, of Newark; J. H. Townsend, of Brooklyn, and J. C. Foler, of New York; capital stock, $100,000. Canada Electric Railway Signal Co., of St. John, N. B.; President, Geo. McAvity; Manager, L. H. Vaughan. Day Electrical Construction Co., of Chicago, Ill.; incorporators, E. F. Getchell, L. D. Thorman, Norman L. Ross; capital stock, $1,000,000. Patent Annealed Compressed Stone Co., of Chicago, Ill.; incorporators, T. A. Wigham, F. W. Keith, S. C. Kanter and A. Heimann; capital stock, $500,000. Chicago Contract Construction Co., of Chicago, Ill.; incorporators, L. D. Condee, H. F. Billings, Geo. B. Lathrop; capital stock, $1,000,000. Multiple Speed & Traction Co., of Chicago, Ill.; incorporators, Octave Chanute, A. P. Gilmore, John L. Cochran, and others; capital stock, $300,000. Harrington Block Signal Co., of Chicago, Ill.; incorporators, Geo. S. Payson, C. H. White and S. R. Hibben; capital stock, $100,000. Standard Car Door Co., of Chicago, Ill.; incorporators, Irwin Veede, O. R. Barnett and Wm. M. Rheen, Central Superior Development Co., of Duluth, Minn; to build gas and water works, electric plant, etc.; incorporators, T. J. Alvord, C. T. Taylor and Andrew Shaw; capital stock, $1,000 000. American Steam & Air Engine Co., of Portland, Me.; incorporators, Granville Cash and A. W. Clark, of Chelsea, Mass.; capital stock, $1,000.000. National Malleable Castings, Co., of Cleveland, O; incoporators, A. A. Pope Oliver K. Brooks and S. C. Smith; capital stock, $3,000,000. Gallup Car Coupler Co., of Omaha, Neb.; incorporators, E. A. Gallup, T. H. Jefferson and F. W. Geise; capital stock, $2,000,000.

Metal Market Prices.—*Rails.*—New York: $30.75; old rails, $22 to $22.50 for iron and $20 for steel. Pittsburg: $26.50 to $27; old rails, $21.50 to $25 for iron, and $16.50 to $17.50 for steel. Chicago: $31 to $32; old rails, $23 for iron and $14.50 to $18.50 for steel.

Foundry Pig Iron.—New York: $15 75 to $17.50. Pittsburg: $14.25 to $16. Chicago: $14.50 to $15.50.

Track Materials.—New York: steel angle bars, $1.75 to $1.90; spikes, $1.95 to $2; track bolts, 2.75 to 3 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.9 to 2 cts. for iron or steel; iron or steel spikes, 2.1 cts.; iron track bolts, 2.8 cts. with square, and 2.9 cts. with hexagon nuts. Chicago: splice bars, 1.95 cts. for iron and 1.85 to 1.95 cts. for steel; spikes, to 2.15 cts.; track bolts, 2.8 to 3 cts. with hexagon nuts.

Pipe.—Cast iron, $27 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—New York, 4.35 to 4.40 cts. Chicago, 4 15 to 4.20 cts. St. Louis, 4.30 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles 2 to 2.1 cts.; tees, 2.5 to 2.75 cts.; sheared iron plates, 2.05 to 2.25 cts.; steel plates, 2.05 to 2.15 cts. for tank, 2.35 to 2.6 cts. for shell, 2.6 to 2.7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.15 to 2.25 cts.; tees, 2.85 cts.; universal iron mill plates, 2.25 cts.; sheared steel bridge plates, 2.4 to 2.45 cts; refined bars, 1.9 to 1.95 cts.; steel plates, 2.25 to 2.35 cts. for tank, 2.6 to 2.7 cts. for shell, 2.8 to 2.9 cts. for flange, 4.25 to 4.5 cts. for firebox. Chicago: beams, 3.2 cts.; channels 3.2 cts.; angles, 2.25 to 2.35 cts.; tees, 2.7 to 2.85 cts.; universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.8 to 2.9 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets 4. to 25 cts.

PROPOSALS OPEN.

Roads.—*South Framingham, Mass.*—Two roads. Plans and specifications on file in County Engineer's office. J. H. Read, Chairman of Board of Middlesex Co. Commissioners, Court House, East Cambridge, Mass. March 3.

Aqueduct.—*Salt Lake City, Utah.*—Brick and concrete aqueduct, 36 ins. internal diameter, from Parley's Creek to the city, about 6 miles. A. F. Doremus, City Engineer. C. L. Haines, Chairman of Board of Public Works, March 3.

Dredging.—In rivers and harbors in Virginia. Col P. C. Hains, U. S. Engineer Office, Washington, D. C. Feb. 21.

City Work.—*Duluth, Minn.*—Grading, sewers, etc. The engineer's estimate is about $275,550. Miron Bunnel, President Board of Public Works. March 4.

Buildings.—*New York, N. Y.*—Court building at 121st St. and Sylvan Pl. Commissioner of Public Works, 31 Chambers St. Feb. 20.

Kansas City, Mo.—Substructure and superstructure of new city hall. S. E. Chamberlain, Superintendent of Buildings. March 2.

Bridge.—*Brookline, Mass.*—Superstructure of a plate girder bridge over the Boston & Albany R. R. at Dean road: 60 ft. span, 50 ft. wide, 75,000 lbs. Plans and specifications with A. H. French, C. E., Town Hall. A. L. Lincoln, Jr., Chairman of Board of Selectmen, Feb. 23.

special reference to structural and architectural iron work for fire proof buildings, roofs, bridges, factories, etc. President, H. C. Williams; Vice-President and Engineer, Philip E. Raqué; Secretary and Superintendent, Frank S. Harrison; Treasurer, F. T. Young. The office is in the *Times* Building, New York City.

The Bush Surface Cattle Guard Co., of Kalamazoo, Mich., has an order from the Richmond & Danville. These guards are now in use on about a dozen railways.

The Detroit Bridge & Iron Works, of Detroit, Mich., are building a 240-ft. double-track draw span for the Chicago & Northwestern, to be located at Milwaukee, and 2 double-track spans 80 ft. long for the Wabash. Also 2 single-track draw spans. They have the contract for the steel trestle approach to the new union depot at Detroit, and are furnishing a large amount of iron work for new bridges on the Michigan Central. They also have the contract for the turntable for a double-track bridge at Vancouver, B. C., and are building several locomotive turntables for the Iowa Central.

The Ingersoll-Sergeant Rock Drill Co. has opened an office at 60 Queen Victoria St., London, England, for the sale of mining, tunneling and quarrying machinery.

The Groton Bridge & Mfg. Co., of Groton, N. Y., has completed an addition to its plant. It has recently erected a fireproof building for the Whitman paper mills, Dansville, N. Y.; the roof for the power house of the Buffalo Cross Town St. Ry. Co., and the roof for the Long Island